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INDIAN

INDUSTRIAL COMMISSION

INSPECTION NOTES

1916-18

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1918

Introductory Note.

These notes do not profess to be authoritative, nor do they represent the unanimous views of the Commission. They have been written by various Members, and indicate briefly some of the most interesting features of the places visited and their bearing on the general industrial question.

G. H. W. DAVIES,

Secretary.

SIMLA:
The 26th April 1918.

Name of Place Visited or Inspected

[*Confidential.*]

INDIAN INDUSTRIAL COMMISSION

Inspection Notes

1916-18

THE DELHI BISCUIT FACTORY.

Visited 26th October 1916.

This factory was started about 1898 and was under the management of an experienced Scotch biscuit-maker. Although the capital was only Rs. 61,000, the company did fairly well till the Directors thought that they could dispense with the services of the expert and depend only upon their locally trained men. The result was not altogether a success, as the quality of the biscuits fell off, and consequently the demand decreased. This was reflected in a very serious diminution in the profits. Lately, since the war began, the factory has obtained large contracts for army biscuits and has been making excellent profits.

The factory is a comparatively small one and consists of a single unit of biscuit-making machinery manufactured by the firm of D. Thomson of Edinburgh. The maximum capacity of the plant is about 4,000 pounds of biscuits a day. The factory was in a very clean condition, but, in the opinion of most members of the Commission, there was too much handling of the material at the various stages of manufacture. The equipment appears to be satisfactory; but, judging from the accounts, the expenditure on fuel is excessive. The ovens are heated by high-pressure steam, and there is a separate steam plant for generating power. There is also a small tin-making plant which is sufficient for the existing scale of operations.

The army contracts keep the factory going; but previously it was not run more than half-time, and sometimes only one-third time. The products of the factory are not good enough to supplant the high-class biscuits imported into India from England and Australia, whilst they are not cheap enough to command a large Indian market.

The Directors take a great pride in the large number of biscuits they are able to make; but from a business point of view the result would probably be very much more satisfactory if they confined their efforts to producing a much smaller number of kinds of biscuits. The cost of packing the biscuits in tins is considerable, and they might be put on the market at much lower prices if packed in paper bags similar to those adopted by some of the biscuit-makers at Home.

The factory is a sound concern and appears to be capable of considerable development.

DELHI INDUSTRIES.

Visited 28th October 1916.

Ivory.

The Commission visited the show-rooms of Fakir Chand and Rughnath Das, opposite the North Gate of the Jumma Masjid, and found behind the comparatively modest exterior very extensive show-rooms, well stocked with the non-textile art products of Northern India. The chief exhibits were the well-known Delhi ivory carvings and miniature paintings on ivory.

No opinion need be expressed regarding the artistic merits of the work as that has frequently been done by art critics. The ivory is imported from Africa, and no Indian ivory is used, as the latter is stated to be liable to crack and warp. Some workmen were seen engaged at their craft, in which they have attained a very high degree of skill. The members were generally of opinion that nothing could be done with this particular branch of industry.

The proprietor said that he did not know the value of his stock; but it must have amounted to several lakhs of rupees. The ratio of turn-over to capital invested is probably very small, and the prices charged in proportion to the cost of the work are, therefore, very high.

It may here be noted that firms like Messrs. Fakir Chand and Rughnath Das would certainly be very strongly opposed to the establishment of any kind of official depôt in Delhi for the sale of Indian art wares, such as has been established in Madras and Mysore.

Gem cutting.

Delhi is celebrated for its jewellers, and the processes of gem cutting were inspected. These do not differ materially from those employed in Europe. Diamonds are neither cut nor polished in Delhi; but stones for Indian jewellery are obtained from Benares. Rose diamonds and brilliants are invariably obtained from London, also amethysts and topaz, the cutting of which apparently the Delhi workmen do not understand, and they are procured from such firms as Messrs. Liberty and Coke. Emeralds, chiefly uncut stones, are obtained from Europe, and rubies from Burma, yellow, white, and blue sapphires, moonstones, alexandrites, and opals from Ceylon, but the best opals come from Australia. Large pearls are obtained from the Persian Gulf and seed pearls from Ceylon, whilst turquoises, of which great numbers are used, are brought from Persia and Tibet.

Wire drawing.

The most important indigenous industry in Delhi is wire drawing and the preparation of gold lace. No less than 40,000 people are said to be still dependent for a livelihood upon one or other of the various branches into which it is sub-divided. In no one workshop are the whole of the processes carried out, and the various stages of manufacture were witnessed in four different shops.

In the first, a cylindrical rod of silver, pointed at both ends, approximately one inch in diameter and weighing 100 tolas, is first covered with a very thin sheet of gold weighing one tola. This is carefully wrapped round the silver rod, which is then heated to redness in a charcoal fire and the thin layer of gold sweated on to the silver. The rod is then drawn through steel dies, gradually diminishing in diameter, till a comparatively fine wire is produced, coated with a thin film of gold. The latter stages of wire drawing were seen in a separate workshop, where the dies used were made of rubies pierced with a very fine hole. The art of boring these rubies seems to have been lost, as the dies are now all obtained through a firm at Surat which imported them from Europe, and probably from Germany. Before the war they cost about 12 annas each, but the present price is Re. 1-12-0. The life of the die is very short; some fail almost immediately, but good ones will suffice for drawing 100 tolas of wire. Special machines are made at Lyons for boring holes, and it is possible that they might be introduced into Delhi with advantage. Obviously, however, a competent workman would have to be brought out to teach the local people how to use the machines.

In a third workshop, the fine wires wound on reels were mounted six on a board and drawn over a highly burnished curved steel plate on which they were hammered into flat ribbons.

In a fourth workshop, the flat ribbons were wound spirally on to a silk thread covering the same completely. A distaff is employed, which is spun rapidly by the workman with one hand, whilst with the other the fine ribbon is wound on to the rapidly rotating silk. Alternately he spins the distaff and feeds the ribbon, and then winds up the length of silk covered with the gilded ribbon.

The processes throughout are primitive in the extreme, and have long ago been superseded in Europe by very elaborate and delicate machinery. Apart from the use of machinery in Europe for carrying out the operations which in India are done by hand, the principal difference in the method employed is that in Europe the gilded surface is produced, as a final operation, by electroplating in a bath, through which the threads covered with the silver ribbon are drawn. It is asserted that the articles so produced are inferior to those made by hand in India, and this is probably true, as, for the sake of cheapness in production, the film of gold deposited by electroplating is probably thinner than that on hand-drawn wire. There is, however, no reason why the coating of gold given by electroplating should not be as thick.

It is, however, possibly open to question whether the method of electro-plating is as good as the method of sweating the gold on to the silver, which is employed in India. The advantage of the European method is that the layer of gold is deposited only where it is wanted, whilst in the Indian method, the gold is on both sides of the ribbon.

In Delhi, they do not appear to manufacture extremely fine gold lace, which is now so very largely imported from Lyons and which is used in the manufacture of gold lace cloths. It is probable that the Indian method is too costly for the fine work. The silk used is imported from China, as Indian reeled silk is too irregular and full of knots.

It appears that five and twenty years ago two men, Maitab Rai and Chuha Mall of the Chowri Bazar, imported a power-driven wire-drawing bench and accessories from England. It is said that they employed a German workman to superintend the factory; but owing to the incompetence and dishonesty of the man employed, the factory proved a failure. The plant was driven by a steam engine, and more than Rs. 70,000 was expended on the experiment. Some of the machines including the long draw bench and the lines of shafting are still in existence; but the workshop is now used as a stable. It is too late to ascertain the real cause of failure. The plant appears to have been much too heavy for the class of work, and it was probably from the very outset unsuited for the wire-drawing done in Delhi. It is almost certain that this is an example of Indian enterprise which ended in failure because it was undertaken without competent technical advice.

FACTORY OF THE DIXON CHEMICAL CO., DEHRA DUN.

Visited 2nd November 1916.

At the outbreak of the war, the fact was very widely advertised that the only source of supply of thymol was in Germany, whilst India had a practical monopoly of the supply of raw material—*ajawain* seed. The preparation of thymol engaged the attention of Mr. Puran Singh, the Chemist of the Forest Research Institute at Dehra Dun, and it seems almost certain that the Dixon Chemical Company have established their factory in Dehra Dun so as to be near the Research Laboratories. The plant for distillation is established in an ordinary bungalow and is obviously the work of amateurs. Nevertheless, thymol is produced, and apparently of as good quality as was formerly available from Germany. Naturally, the managers were somewhat reticent regarding the details of the processes. They stated that they were making 1,000 pounds of thymol a month, the current wholesale price for the same on the London market being about 33 shillings a pound. It is open to question whether the capacity of the plant at work at the time of the Commission's visit was as large as was stated, and it is probably an anticipation of events, as we were shown a very much larger still which has recently been constructed for the company in Bombay.

The *ajawain* seed after removal from the stills contains about 20 per cent of oil, for which possibly some commercial use may be found. The crushed seed is an excellent food for cattle, and independent testimony in Dehra Dun was forthcoming as to its value as food for horses that were out of condition. This is not an unimportant matter, as, with so small a yield of thymol, it will probably be necessary to make the most of the by-products.

MATCH FACTORY, BAREILLY.

Visited 3rd November 1916.

In the note on the match-making industry supplied by the Government of the United Provinces to the Commission, a brief history is given of the enterprise initiated by Messrs. Gavin Jones & Son of Cawnpore, the outcome of which is the match factory now working at Bareilly, which was inspected by the Commission. At the time of our visit, the factory, working ten hours

a day, was able to turn out 750 gross of boxes of matches a day, and the Managers stated that its capacity will have to be doubled before it can be expected to yield profitable results. The wood used, both for boxes and splints, is *bombax malabaricum*, the Indian cotton tree. For boxes it is said to be satisfactory, but it yields only splints of an inferior quality. Attempts are now being made to secure a supply of blue pine, experiments with which have yielded much better results. All the machinery is of German manufacture, and even now it is being run under the supervision of a German mechanic, who has been specially released from internment for the purpose. This class of machinery is not likely to have a long life, and, at any rate, renewals and repairs will probably prove difficult and costly.

The match trade in India has in recent years undergone considerable changes, partly due to legislation against the use of white phosphorus and partly due to the war, which has enabled Japanese matches to oust Swedish matches to a large extent, whilst the supplies which formerly came from hostile countries have been entirely cut off. The price of Swedish matches has risen considerably, but Japan has been able to place on the market enormous quantities of inferior matches at practically pre-war prices. The Bareilly matches appear to be of about equal quality to the Japanese, but are distinctly inferior to those imported from Sweden. The price at the present time is annas fifteen a gross, a rate which would yield a good profit, were it not for the heavy expenses due to the enhanced prices which have to be paid for chemicals and paper.

The factory is supplied with wood from the Forest Department at one anna per cubic foot, which is less than its value as fire-wood. All the chemicals used are imported, also the paper wrapped round the boxes. The economic advantage to India from the establishment of the match industry is therefore comparatively small, and the only valid reason for granting concessions to this factory is the possibility that ultimately it may prove a commercial success; and India may be rendered to some extent independent of foreign countries for supply of matches.

There have been many attempts during the past ten years to make matches in India, but so far with but limited success, owing to the inferior character of the wood, and much money has been wasted. Any further assistance rendered by the State for the establishment of match factories should be concentrated on one concern, which obviously should be that which offers the best prospects of final success. As the conditions under which the other pioneers of the match industry are working are not known to the Commission, it is not certain that the Bareilly Match factory should be selected as the most deserving of further Government assistance.

FURNITURE WORKSHOPS, BAREILLY.

Visited 3rd November 1916.

One of the largest furniture factories in Bareilly was inspected by the Commission. The work was of the average quality to be found in similar factories in many of the large towns and cities of India. Bareilly enjoys the advantage of cheap supplies of wood of a rather good quality for furniture, and there are a large number of artisans engaged in the industry of furniture-making. Judged by modern standards, their designs are inferior and their workmanship second-rate, whilst, the tools they employ are of the usual primitive type to be found among the indigenous carpenters.

A second furniture factory was inspected, which is run by a Co-operative Society, consisting of members who have subscribed among themselves for 53 shares of the value of Rs. 50 each. The Board of Directors of the Co-operative Society acts as a sort of middleman and distributes the orders received among some of the members, who work on the premises of the Society. Piecework appears to be universally employed, and the accounts of the Society showed that it had made a profit sufficient to allow of the distribution of a dividend of

10 per cent on the shares and bonus of 6¼ per cent on the piecework money paid to the operatives. The Co-operative Society has borrowed something like Rs. 28,000 from the District Urban Bank, and it can scarcely be questioned that the advances made by the Bank to the Society are altogether out of proportion to the capital which the Society controls. The funds are invested in a building used as a show room, which contains stock valued at an amount equal to at least one year's output of the work of the Society. The actual cabinet making is carried on in a very *kutcha* shed in the compound, and it is hard to discover what useful purpose the Co-operative Society has fulfilled. As a trading concern, its position is unsound, and it is quite certain that the funds of the District Urban Bank will not be easily recoverable.

This Co-operative Society may be regarded as an attempt to apply co-operative methods of working in an industry not needing such, and the Board of Directors has apparently been unable to achieve any useful result. Unless some drastic measures are taken to put the Society on a sounder basis, the inevitable winding up, which looms in the future, will involve the District Bank in a very heavy loss.

The control of the Society is in the hands of people who have no knowledge of the trade, and they also control the funds of the District Bank. This should not have been allowed, as the Directors of the Bank will probably be tempted to throw good money after bad to keep the Co-operative Society going. The solvency of the Society, at the present moment, entirely depends upon the sale value of the stock, and there is an inevitable tendency in all such factories to accumulate a certain amount of stock which is either unsaleable or can only be disposed of at considerably reduced prices. Owing to the direction of the Bank and the direction of the Society being in the same hands, there is an entire absence of healthy criticism of the management.

GOVERNMENT CARPENTRY SCHOOL, BAREILLY.

Visited 3rd November 1916.

Bareilly is the centre of a large trade in cheap furniture and, some five or six years ago, a Government School of Carpentry was started with a view to improving the technique of the workmen. An English carpenter of experience was brought out and made the superintendent of the School, which was placed under the management of a local committee presided over by the Commissioner of the Division.

The School is under the Education Department; but the control is practically in the hands of the Director of Industries, who inspects the School and is a member of the local committee. The policy of the School, the design of the buildings and the nature of the equipment appear to have all been determined by the superintendent, and to have been approved by the various authorities over him. A very large amount of money has been spent. Good workshops and class rooms have been built, and the equipment is beyond all comparison better than that of any other industrial school of the same character in India.

Boys are admitted to the School for a course of training extending over six years, but as yet there is no record of passed pupils to show whether the objects of the School have been achieved. The course of training is obviously too long, and it is doubtful if the School has been a remarkable success, which is the opinion expressed by the local Director of Industries; in fact, it is open to question whether the School is not working on altogether wrong lines, and attracting a class of pupils who will ultimately find as much difficulty in making a living as carpenters, as will their contemporaries who are receiving a purely literary education.

It is noteworthy that the sons of the artisans working as carpenters in the town are not attracted to the School and that the boys mainly come from other classes. Granted the fact that the artisans are in need of a better training and that the wood-working industry in Bareilly is not in a flourishing condition, it seems hardly rational to introduce a new class of carpenters

who, if they succeed, will oust the present workmen from their trade. We may accept the fact that it is difficult to get high-class furniture made in the United Provinces; but it is more than doubtful if there is any large demand for expensive cabinet work. A comparatively small number of first-class master carpenters would, at any rate, supply for some time to come the immediate demand.

We were informed that the annual cost of maintaining the School is about Rs. 37,000, of which apparently Rs. 6,000 or 7,000 is recovered by the sale of work done in the School. As the number of pupils in the School is now about 70, the cost of training each boy comes to about Rs. 35 a month, that is to say, if the boy goes through a six years' course, his training will cost the State about Rs. 2,500, which can only be regarded as an extravagant amount to pay for the education of a carpenter.

The School is said to influence the artisans in the town indirectly; but little evidence of this could be seen in the factories which the Commission inspected. A radical change in policy seems to be indicated, chiefly with a view to bringing the resources of the School to the aid of the artisans in the town. There is a large amount of wood-working machinery in the School, the capacity of which must be greatly in excess of the requirements of the School, and this should be employed for the benefit of the cabinet-makers in the town, who might be allowed to get work done at such rates as would yield a reasonable profit. The saw mill might be used to convert logs into suitable scantlings, and these could be stocked in large quantities, as would be done in any timber yard.

It is understood that the purchase of a wood-seasoning plant is under contemplation, and this might certainly be installed so that seasoned wood could be supplied to the artisans in Bareilly.

The majority of the boys in the School should be the sons of artisans in the town, and to attract them to the School, it will be necessary to pay them wages from the very beginning. This should be done, and the boys put through a course of instruction in carpentry, and as soon as they acquire sufficient handicraft skill, they should be employed on the manufacturing of things for sale. Such a course need not extend over a period of more than three years.

A comparatively small number of boys, certainly not more than five a year, might be admitted to go through a more diversified course of instruction in wood working. Such boys should have completed a good elementary education, as would be indicated by their having obtained a School Final or School-Leaving certificate. The training for these boys should be much on the same lines as that now given to everyone in the School; but shortened, so that it would be possible for one, if not two years of the course, to be spent in the Lucknow School of Arts and Crafts, where more attention is paid to instruction in designing. If the School is working in the town for the benefit of the artisans in the town, it is not unreasonable to attempt to recover as much as possible the working costs by the sale of the products of the School. No doubt, the School would compete with private enterprise in a sense, but such competition should be a stimulus rather than otherwise to the industry.

Since the above note was written, the superintendent of the School has furnished a statement showing that the capital outlay on buildings up to date is Rs. 73,095, and that the expenditure on tools and machinery is Rs. 41,045. During the year 1915-16, work to the value of Rs. 8,280 was done for other Government departments, and ambulance boxes were supplied to the value of Rs. 2,183. Further, work valued at Rs. 2,440 for the improvement of the buildings and equipment of the School was completed during the year.

THE UPPER INDIA PAPER MILLS, LUCKNOW.

Visited 4th November 1916.

These mills were started in 1879 and manufacture paper chiefly from *baib* grass. Other sources of raw material are old gunny bags and other waste

materials suitable for the purpose. The paid-up capital of the company is 8 lakhs of rupees and during the last eight years, it has paid an average dividend of 7 per cent. The outturn of paper is about 13 tons a day and two Fourdrinier machines are in use.

The company is entirely an Indian concern but employs four European foremen. The work is carried on continuously and there are two shifts. Only low qualities of paper are manufactured and the directors are apparently content to continue running the mills on the restricted lines which they have found to be moderately successful. There was not the slightest trace of scientific control nor any signs of development.

THE SCHOOL OF ARTS AND CRAFTS, LUCKNOW.

Visited 4th November 1916.

The Fine Art classes of this School are on a restricted scale and the pupils, who do not show fair promise, are quickly eliminated. The lithographic class is an important section and has recently been put under an expert brought out from home. The principal crafts taught in the School are wood working and design, wood carving, gold and silversmith's work, brass and copper work and sign painting. Excluding the purely art sections, about two-thirds of the pupils are following their hereditary occupations. The School has only been in existence for five years, which is far too short a period to produce results which may be judged. It is run on the same general lines as are followed in the schools of arts in Madras and Bombay and there is no reason to doubt that it will meet local requirements with equal success. It will probably be found advantageous to link up this School with the various industrial schools throughout the province and to draft some of the more promising artisan apprentices into this School for a course of training in design. Above all things, the arts craftsmen require intelligent instruction in this direction as they are now completely out of touch with the environment of their patrons.

Attached to the School, there is an Arts and Crafts Museum containing many excellent specimens both of Indian and foreign work. It is needless to say that this should prove of great value to the students, but it would be of advantage if the best specimens of work turned out in the School were placed in the Museum rather than a comparatively small income derived from their sale. The same idea should be followed in every industrial school to the extent possible with the resources at the disposal of the management. Schools of arts and crafts such as this at Lucknow are essentially educational institutions, and though there is no objection to the sale of work done in the school, it should not be regarded as an important source of income. These remarks do not apply to the lithographic section, the success of which may to some extent be measured by the amount of commercial work the pupils are able to turn out.

The question will possibly come up for consideration as to whether or not it will be desirable to establish Government workshops of arts and crafts to be run on purely commercial lines. At the present time, the tastes of the wealthy people in India incline towards the productions of Europe and they look with contempt on the indigenous arts and crafts; on the other hand, in Europe and America there is a large demand for art work such as can be turned out in India, and it is probably sound policy to take steps to meet the demand. The dealers in art curios have had a most disastrous influence, and it is necessary, if the craftsmen are not to degenerate further, that they should be brought into touch with more appreciative patrons.

It may be suggested that more attention might be given in Lucknow to training in the decorative arts. A good deal of money is now being spent abroad on these which might well be retained in the country.

THE MECHANICAL ENGINEERING SCHOOL, LUCKNOW.

Visited 4th November 1916.

This School was started in 1900 and has been continuously under the superintendence of Mr. Swinchatt. From a very elementary industrial school it has developed into one of much higher grade for the training of men who in after-life will be in charge of small engineering plants or foremen of departments of mechanical engineering establishments. The equipment is on an extensive scale, and both steam engines and internal combustion engines are installed either for experimental purposes or for driving the workshops.

The pupils undergo training in the School for three years, and they are then apprenticed in engineering works for two years, during which time they are paid Rs. 8 a month by Government, and their employers are expected to pay them a minimum wage of Rs. 12. At the end of the five years, those who have passed through the course satisfactorily are granted the diploma of the school. The scheme has only been in operation for six years, and a sufficient number of students have not yet passed into practical life for any opinion to be formed as to the nature of the results achieved. Such evidence as is available regarding the utility of the School is all in its favour, and there is but little doubt that the men will easily find employment and will be of material assistance in the development of small rural factories for the preparation of agricultural produce for the market.

There is a machine-tool shop, a pattern maker's shop, a foundry, a fitter's shop, a forge, and electrical plant sufficient to familiarise the pupils with the running of dynamos and motors. The underlying idea of the education given in the School seems to be to turn out a class of artificers, the nearest equivalent of which is the English millwright. Experience in other provinces suggests that there is a need for such men.

Only a detailed study of the curriculum of the School would justify a definite expression of opinion as to its appropriateness to the end in view. Possibly, too much time is spent in the machine-tool shop and too little at the forge and at the fitter's bench, where manual dexterity, so essential in the class of men under training, can be best acquired. The School is attended by boys from all parts of the province, and there is a hostel attached for their accommodation.

THE CAWNPORE WOOLLEN MILLS, CAWNPORE.

Visited 7th November 1916.

The Commission visited these mills under the guidance of Sir Alexander McRobert. He pointed out to the Commission that, so far as his knowledge goes, the mills are unique in regard to the variety of work which they undertake. Both woollen yarn and worsteds are spun and, in normal times, a great variety of fabrics are woven. In the early days of the mills, 90 per cent of the output was on Government account; but in late years, it has dwindled down to about 10 per cent. Since the outbreak of war, it has again risen to nearly 70 per cent. Beside the raw material available in India and imported from Tibet, wool is also imported from Australia and the Cape.

The mills are one of the largest industrial undertakings in Cawnpore and employ at the present time about 4,000 hands. The buildings and equipment are of a very modern type, and the manufactures of the company enjoy a high reputation throughout India. These mills are an excellent example of what can be accomplished in India under none too favourable conditions, when enterprise, technical skill and business aptitude are displayed to a very high degree in the development of a manufacturing business.

BRUSHWARE, LIMITED, CAWNPORE.

Visited 8th November 1916.

This is a comparatively small factory established about 20 years ago in Cawnpore for the manufacture of all kinds of brushes. The bulk of the output

is to meet the requirements of the Military Department; but the company also manufactures every variety of household brushes and a very high grade of toilet brushes, the principal limitation in the latter branch being that only wood is used for backs. Pigs' bristles and a variety of suitable fibres are used. Considerable quantities of the former are obtained from China and after grading into various lengths, those unsuited for the local trade are exported to Europe. The factory is sufficiently equipped with machine tools but all filling of brushes is apparently done by hand. As regards quality and finish, the manufactures of the company appear to be equal to the best imported goods.

THE ELGIN MILLS, CAWNPORE.

Visited 8th November 1916.

These mills date back to 1864 and are among the earliest of the modern industrial enterprises of Cawnpore. They have lately passed from private management into the hands of a firm of managing agents. The cotton spinning is entirely confined to low counts, and the greater part of the yarn is worked up into finished goods within the premises of the company. Tents and *dhurries* are important items of their present output.

MESSRS. COOPER ALLEN & CO., LTD.

Visited 9th November 1916.

The factory, owned by this firm, is one of the largest establishments in Cawnpore, and was founded in the early sixties by a Mr. Cooper who was an indigo planter in Bihar. In the initial stages of its development it received considerable financial assistance from Government. The factory includes a very large tannery and a boot-making plant, which at the present time is supplying to the Military Department about 5,000 pairs of ammunition boots per day. A good deal of lightly tanned leather produced in Madras is re-tanned in the factory. The bulk of the tanning is done with *babul* bark whilst myrobalams are also used to some slight extent. The depletion of th local reserves of *babul* trees necessitates drawing supplies from an ever-increas ing distance, and the price of the bark appears to depend to some extent upon the demand for charcoal, as, when the trees are cut down and the bark stripped, the wood is converted into charcoal. In this connection, the possibility of establishing wood-distillation plants for the manufacture of charcoal and the recovery of the by-products seems to require investigation. At the same time, it is possible that the market for charcoal might be extended by the encouragement of the use of suction gas plants worked with charcoal to supply gas for power purposes. The company apparently relies upon Government business to keep going and has shown comparatively little enterprise in the development of outside lines of business.

Although a separate concern, the North-West Tannery is under the same management and here a very much greater variety of work is turned out, including bags, trunks, dressing and suit cases, a speciality being the manufacture of articles from crocodile skins, of which fairly large numbers can be procured in those months of the year when the neighbouring rivers are low.

THE GOVERNMENT HARNESS AND SADDLERY FACTORY, CAWNPORE.

Visited 10th November 1916.

This is a factory belonging to the Ordnance Department and entirely devoted to the manufacture of military equipment. The working is controlled by the officers of the Ordnance Department, who have specially elected for the service and have undergone a very thorough course of special training in the manufacture of leather and in the working of the same into military equipment. The inspection of the factory disclosed ample evidence of technical skill and

administrative ability in the equipment and organisation. The factory is now worked under war conditions, and the output is considerably in excess of what is normal in peace times.

It has often been suggested that this factory was unnecessary and that it was an expensive way of providing for the needs of the Military Department in the matter of leather equipment. It should therefore be noted in justification of the policy hitherto pursued that there has been no increase in the cost of production since the outbreak of war and that the actual cost price of articles is from 25 to 37½ per cent below the rates at which private firms are willing to tender. After the outbreak of war, there was for a time a very heavy slump in the price of hides, and the total cessation of exports to Austria and Germany has tended to keep prices low. This has been further emphasised by high freight and insurance charges. The result is that up to date the cost of production of leather goods in India has not risen.

Attention was drawn to the leather belting turned out by the factory for other Government departments. Whilst perhaps not of the very highest quality, it is sufficiently good for most practical purposes and suggests that this branch of the leather trade might well be developed in this country. The value of the imports into India, including belting made of other fabrics besides leather, was as follows:—

	£
1912-13	245,246
1913-14	281,937
1914-15	239,791

With the development of industries, the amount required in the country will steadily increase. This may be counteracted to some extent by the increasing use of electro-motors for direct driving. For the generation of power steam is employed, the fuel used being the spent tan from the tan pits supplemented by other fuels. At the time of our visit, they were burning *mahua* cake obtained from the Premier Oil Mills. This cake should be useful as manure as it is said to contain over two per cent of nitrogen, but with such a low nitrogen content it will probably not bear any very heavy transport charges. We were informed that the *mahua* cake has been taken for fuel to help the Oil Mills to dispose of their cake, as the local demand for manure was not sufficient. The price paid for the cake was eight annas a maund.

Our attention was drawn to a very complete battery of drop hammers for stamping out the various forgings required in the factory. In one instance, it was stated that the cost of doing the work had been reduced from ten annas by hand labour to nine pies with the drop hammer.

VILLAGE SETTLEMENTS, CAWNPORE.

Visited 11th November 1916.

The improvement of the conditions of labour has received a considerable amount of attention in Cawnpore, and both the Cawnpore Woollen Mills and Messrs. Cooper Allen & Company have built very large settlements in which a considerable number of their employés are now housed. The Commission visited both settlements and were considerably impressed by the care and forethought displayed in their design. The settlements are within a reasonable distance of the factories with which they are connected and seem to afford a practical solution of the housing problem. Though the rentals received are only sufficient to yield a return of about one per cent on the capital invested, the proprietors are satisfied that the indirect return from the increased efficiency of the workmen living under more sanitary conditions justifies the outlay. The two settlements are roughly about the same size, and each provides housing accommodation for about 4,000 people.

THE CAWNPORE SUGAR WORKS, LIMITED.

Visited 12th November 1916.

This factory was not visited by the whole Commission, but it is of sufficient importance to justify a brief note. It was started about 23 years ago to make refined sugar from *gur*, using the molasses for the manufacture of alcohol. During the current year, 275,000 maunds of *gur* have been treated, yielding about 4·7 per cent of sugar.

Attached to the sugar works is a distillery capable of turning out 30,000 gallons of London proof spirit per month. The actual outturn in 1915-16 was about 134,000 gallons. Under the terms of the company's contract with Government, *mahua* spirit has also to be manufactured, so that there is a large surplus of molasses which cannot be used in the distillery and is sold in the bazaar.

The firm managing this factory have now turned their attention to the production direct from the sugarcane of *gur* for eating, and have set up new plant near Gorakhpur capable of dealing with five tons of cane per hour. This experiment is one of great interest, as it is possible that the solution of the Indian sugar question lies rather in the improvement of the manufacture of *gur* than in the development of central factories for the production and refining of sugar.

JOHN'S FLOUR MILLS, AGRA.

Visited 13th November 1916.

The mill has a capacity for 10½ sacks of flour per hour, and the machinery was supplied and erected by the firm of Henry Simon of Manchester. The plant is of a very simple character and is designed to supply the needs of the local market rather than to manufacture a high grade of flour. The wheat is broken down by corrugated rollers in three stages, whilst the semolina and middlings are reduced to fine flour and purified in four stages. The flow sheet of the mill is therefore a short one, but it is adequate for the purpose. Normally, the mill should produce from good wheat 50 per cent. flour, 32 per cent. *atta* and 18 per cent. bran; but usually rather more flour and *atta* are made and somewhat less bran, which means that the *atta* contains a good deal of finely ground offal and bran.

Indian wheat is notoriously dirty, and a wheat-cleaning plant is a *sine qua non*. That installed in the John's Mills, Agra, is very complete.

In England, one would expect to run this mill from 6 o'clock on Monday morning till 6 o'clock on Saturday evening; but here, the mill is only run through the hours of daylight as, apparently, the market is not big enough to absorb what might be considered the proper output of the mill. Nevertheless, the flour mill is said to yield a very good return to its owners. It is certainly well managed; the machinery was in excellent running order, and the manager appeared to be an experienced and intelligent man.

It may be noted that the manager of the Cawnpore Electric Supply Company stated that they were supplying power to a number of small stone mills electrically driven. These mills yield a product something like that turned out by the old English mills, many of which were run by wind power. The very elaborate system of gradual reduction of roller milling which superseded the old stone mill is totally unsuited to Indian conditions, and the comparatively simple plant at Agra seems to represent about the best that can be done for the Indian market on the roller system of flour milling.

THE FIROZABAD GLASS WORKS.

Visited 14th November 1916.

The Commission visited Firozabad to see the glass industry which is centred in that town. The industry is a very ancient one and is chiefly

carried on to supply the innumerable glass bangles which Indian ladies of all classes wear till they become widows, when they have to eschew all ornaments. Formerly, the glass for the bangles was made from indigenous materials gathered more or less in the locality; but in recent years, since the manufacture of *chouri* glass was started at Rajpur, the use of local materials has been given up, and the glass is now made with imported soda, lime from Katni and sand from the country to the south of Allahabad. The coal of course comes from Bengal.

Bangle making is a very old Indian craft, but the indigenous industry has for a long time experienced the effects of unrestricted external competition; first it was Chinese bangles, then these were ousted by Austrian and now, since the war began, Japanese competition has proved very severe.

Firozabad possesses no natural advantages which tend to make it a centre of the glass trade, and it flourishes there almost entirely because of the hereditary skill of the glass bangle makers. The trade is divided into two branches, one devoted to the production of chouri glass which is in the hands of Hindu capitalists; the other, dealing with the *chouri* glass as the raw material, converts it into bangles. There are 6 or 7 factories for the production of glass, and between 50 and 60 for the production of bangles. The largest glass works in the town are just outside the railway station, and here the proprietors have installed a gas-heated furnace of quite a modern type. The factory is managed by an Austrian with the Italian name of Mozina. The glass manufactured is a very soft one obtained by the use of a considerable proportion of alkali. This is necessary because the bangle makers work at a comparatively low temperature and would be unable to deal with hard glass. For this reason, apparently, "cullet" or broken glass is not employed in Firozabad. The output of the furnace is about 100 maunds or nearly four tons of glass a day. The bangle makers work in gangs of from 12 to 20, round a central furnace fired with wood. The furnace is cheaply constructed of mud, and the temperature is not very high. Each bangle maker has an assistant, and the methods employed are exactly the same as, until recently, were in use in the south of India.

A Parsi firm, Messrs. B. Framroz & Co., have, since the outbreak of war, made considerable strides in the manufacture of bangles in imitation of those imported from Austria. They have discovered that suitable glazing materials can be obtained from England, and after a number of experiments have succeeded in constructing a muffle in which these glazes can be melted on to the bangles successfully.

The industry appears to be in a very flourishing state, evidence of which is visible in the glass factories, nearly all of which are provided with costly brick chimneys when cheap iron ones would do equally well. The industry appears to be in the hands of enterprising intelligent men who are willing to adopt any suggestions that seem to be practicable. As to the bangle makers, no deductions can be made from their workshops and equipment which are of the most primitive type; but as they can earn from twelve annas to Rs. 2 a day depending upon their skill, they are well off when compared with other Indian artisans.

Between 20 and 30 tons of glass bangles are the estimated daily output. The economics of the industry should be studied carefully. Till that is done, it would certainly be unwise for Government to intervene either to improve the industry in Firozabad or to establish it elsewhere.

The glass bangle industry may continue at Firozabad because of the hereditary workers and the fact that it is a recognised market for such goods. It may even expand if attention is concentrated upon improving the methods of manufacture and the introduction of new designs; but attempts to teach them glass-blowing are likely to fail as the workmen are very conservative and they have no experience of this branch of the industry.

It should be noted that in the glass industry there is but little waste of the raw materials in the processes of manufacture, and therefore the industry of glass blowing is best carried on in the neighbourhood of large markets for glassware, as the freight on the raw materials to the centre of

consumption will be much less than on finished goods, which are not only very bulky but are also of a fragile character and require careful packing. A cheap supply of coal will undoubtedly prove an important factor in the successful establishment of a large glass industry and, combining this with easy access to the market, it seems that the coal districts of Bengal, which are close to Calcutta, are indicated as suitable for the establishment of this industry.

THE GOVERNMENT WEAVING SCHOOL, BENARES.

Visited 15th November 1916.

The Government Weaving School at Benares was started about 4½ years ago with a view to giving instruction in weaving. Rs. 75,000 is said to have been expended on the land and buildings, and the equipment probably cost half a lakh of rupees. Besides hand-loom weaving, there is a class the pupils of which are instructed in the working of hosiery machinery, the idea being that, having gone through a training extending over one year, they should be able to set up small hand-power hosiery factories for the manufacture of socks, stockings and vests. This class may be disposed of in a few words. Its aim is perfectly definite, and it is strongly supported by the makers of hosiery machinery who, through their agents in Lucknow, are prepared to sell the same on the hire-purchase system. The demand for hosiery is steadily increasing, and there seems to be no reason why, for a year or two, this class should not be successful. If the making of hosiery on these machines is profitable, the supply of such goods will soon exceed the demand, and there will be a glut in the market and a corresponding fall in prices. Hosiery machinery will change hands frequently, and people will get local instruction and the attendance in the school classes will probably fall off. The hosiery class should therefore be looked upon as a temporary measure, the utility of which is not likely to be prolonged.

The Weaving School must be regarded as a dismal failure. There was nothing being done in the School that is not ordinarily done much better in a bazaar and the machinery and plant in use in the School, which are not found in the bazaar, are quite unsuited to the conditions under which Indian hand-loom weaving is carried on. The Commission was informed that there were few boys belonging to the weaver community in the School, and it therefore seems more than doubtful if there is any advantage in giving elementary education in weaving to boys, who, if they become successful weavers, will simply swell the number depending upon hand-loom weaving for a livelihood.

There is evidence to show that the hand-loom weavers in India are using every year increasing quantities of yarn; but this is probably due to the increasing efficiency of their appliances rather than to any substantial increase in the numbers of the community. The actual number of working weavers is either stationary or possibly slowly decreasing. Weaving schools should be for the benefit of the artisans of the weaving community, and in this respect the Benares Weaving School is found wanting. As regards the training given in the School, it seems to be equally faulty.

The looms are divided into three classes, pit looms with the fly-shuttle slay, frame looms and pedal looms manufactured by Messrs. Hattersley and Son of Keighley. There were also a number of frame looms fitted with dobby or jacquard machines, but these were not at work. There is no objection to the pit looms or to the frame looms, but the former were only working on very narrow cloth which is not at all adapted to demonstrate the merits of the fly-shuttle slay. Hattersley looms are only a light type of power loom, modified so as to be worked with a treadle. These have been tried in many parts of India and have failed hopelessly, as the physique of the Indian weaver is not sufficient to enable him to drive these looms for more than a short time. A single power loom driven by an electro-motor is intelligible, but a power loom driven by an ill-fed cooly is an absurdity which could only be perpetrated in an educational institution. No work done in the School was shown to the Commission except plain weaving, and the most of it was not of a very high quality.

The School is said to cost Government about Rs. 27,000 a year, and only about Rs. 2,500 is recovered by the sale-proceeds of the work done. There may be a need for a weaving school in these provinces but it does not appear to be in Benares, and it is more than probable that the direction in which the hand-loom weaver needs assistance is not so much in the matter of improving the technique of his methods as in marketing the productions of his looms. There is a magnificent organisation in India for the sale of piece-goods, that is to say, the woven goods manufactured by power looms. Why there cannot be an equally good organisation for the sale of hand-woven goods is a question which requires to be investigated. If such an organisation could be created and the sphere of the hand loom definitely demarcated, the question of introducing improved technical processes would be an extremely simple one. It is, however, perfectly obvious that a Government weaving school will not solve the problem.

THE BIHAR SCHOOL OF ENGINEERING, BANKIPORE.

Visited 16th November 1916.

The Bihar School of Engineering was founded in 1899, and is the concrete embodiment of local sentiment in favour of rendering Bihar independent of Bengal in matters of education. Local subscriptions amounting to 2½ lakhs of rupees provided the buildings and equipment and, though one might criticise the details, the general result of the expenditure is very satisfactory. Mr. Walford, the Principal of the School, joined in 1900, and to him is due the credit for organising the present courses of instruction. The School is designed to train overseers and sub-overseers for the Public Works Department and for District Boards and Municipalities. There is also a vernacular class for draftsmen and surveyors and classes for the training of artisans. Boys are admitted to the overseer classes on the results of an entrance examination, and the standard of general education required is that of the Calcutta University Matriculation examination. All the instruction is given in English. The principal feature of the curriculum is the very large amount of time which the boys spend in manual training, three hours every day being devoted to workshop practice and for a period of six weeks in a year the students are taken out into camp and put through a course of field instruction in surveying.

There seems to be an honest attempt to train the boys rather than to cram them with information. During the first year, they are taught carenptry, during the second, blacksmith's work, during the third, moulding and during the fourth, fitting and machine work. Those who satisfactorily pass through the School are then apprenticed for a year to Executive or District Engineers to get experience on actual work of construction. They receive no pay from the officers they serve, but are supported by stipends given by Government. The award of the diploma of the School depends upon a satisfactory report being received from the officer to whom they have been attached.

About 60 students are admitted every year, and the great majority leave at the end of the second year with a sub-overseer's certificate, and only 16 or 17 pass through the complete course of instruction. No very large amount of time is devoted to lectures or theoretical work. Although the students, when they leave the School, may not know so much as the equivalent students from other engineering colleges in India, it is probable that they are better trained.

The vernacular classes are meant to afford instruction in surveying and levelling and in drawing. In the artisan classes instruction is given to motor mechanics, carpenters, blacksmiths, moulders, painters and fitters. The workshops are under the management of a good English mechanic and are efficiently run. The income from the sale-proceeds yields a profit of about Rs. 5,000 over the extra cost entailed by these classes and is chiefly derived from repair work to, and painting of, motor cars. Since the constitution of Bihar and Orissa as a separate province, the School is unable to meet the local demand for trained engineering subordinates, and proposals are before the Government for enlarging the School.

All the boys in the subordinate classes live in a well appointed hostel; but the pupils of the artisan classes reside in the town. The School is pleasantly situated on the banks of the Ganges and may be regarded as an efficient and up-to date institution.

The Principal is a member of the Provincial Educational Service, and it is recognised that, as a member of that service, the highest pay he can obtain is inadequate, and he has therefore been given in addition personal allowances. This is not a satisfactory arrangement. If the School is to remain under the control of the Director of Public Instruction, the status should be recognised by making the Principal a member of the Indian Educational Service, especially as he is now the chief adviser on technical education in the province.

THE JAPAHA SUGAR COMPANY, MUZAFFARPUR.

Visited 22nd November 1916.

This factory is an example of the enterprise displayed by the Bihar planters when faced with ruin owing to the competition of synthetic indigo. They took to sugar planting. The cultivation was, of course, new to them, and they have hitherto followed the indigenous methods, and it yet remains to be seen how far the prospects of the industry can be improved when technical knowledge and skill is brought to bear upon the growing of the canes, similar to that which has been displayed in the manufacture of sugar. Under the indigenous system, the canes are crushed in bullock mills and the juice boiled down to either *rab* or *gur*. A country bullock mill worked with one pair of cattle will crush about a ton of cane a day, whilst the mill visited by the Commission crushes 12 tons of cane an hour and works continuously through the crushing season. Apart from the enormously increased capacity of a central station mill, an important advantage is gained by the much more efficient extraction of juice, which, in a plant of this type, with good cane, exceeds 80 per cent., as against 65 to 70 per cent. with the country mill.

It is open to question whether better financial results would not have been obtained by adopting the central station method for manufacturing a highly refined and purified *gur* on a very large scale. The native of India is accustomed to *gur* and the poorer classes, which form the bulk of the community, unquestionably prefer *gur*, to sugar. The difficulty with *gur* made by the ryots is that usually it is of an inferior quality and will not keep; but, by more perfect methods, a very much better article, as easily handled as sugar, can be turned out.

The sugar factory is situated about six miles from Muzaffarpur and is capable of dealing with 300 tons of cane a day. The crushing season commences in December and finishes in April. Assuming 120 working days and dealing with 300 tons a day, 36,000 tons of cane are dealt with. With an average crop of eight tons per acre, the sugar mill is capable of handling the produce of 4,500 acres. All the cane is brought to the mill by carts and on receipt at the factory it is weighed. Then it passes to the crushing rolls. These consist of two three-roller mills preceded by a pair of cane crushers. The juice is pumped to a sulphite box where it descends through a series of trays against an ascending current of sulphur-dioxide. By this means it is to some extent decolorised. It then passes into steam-jacketted defecators where lime is added, and the heavy impurities removed and carried to the scum tanks. From the defecators the juice is pumped into a series of eliminators where more lime is added to neutralise the acidity of the juice, which is then heated to boiling point, when the scum rises to the surface and is scraped off. The juice is then filtered through bag filters and passed into a triple effect evaporator where it is reduced to the consistency of a syrup. The final boiling is done in vacuum pans, and the massecuit resulting therefrom is passed into crystallisers, where it is kept in motion till it can be centrifugalled. The centrifugals are all water-driven. From the centrifugals the sugar is taken to the mixing floor, thence passed through a dryer and finally crushed, when it is packed and carried to the warehouse. The molasses from the first sugars are treated again,

and a second sugar produced of a slightly inferior quality; the runnings from the second sugar are allowed to settle, and any sugar crystallising out is sent to the defecators and re-treated.

The machinery and plant were supplied by the Harvey Engineering Company of Glasgow and, though not of a very elaborate character, the equipment is of a first-rate quality. No information is obtainable regarding the percentage of juice extracted from the cane, and this is probably not very high. The megasse is burnt under the boilers used for raising steam, but is insufficient, and about 500 tons of coal and a certain amount of wood in addition are used is each season. There is a local demand for the molasses which are disposed of locally through a contractor, who takes them away in kerosene oil tins. This mill was one of the earliest erected in Bihar, and as much as Rs. 2-8-0 a maund was paid for the molasses. Last year, the price realised was about Rs. 1-12-0 a maund which is now considered very good.

THE CUTLERY FACTORY, MUZAFFARPUR.

Visited 24th November 1916.

Mr. M. Bose, the proprietor of this factory, has submitted evidence to the Commission detailing the reasons which led him to take up this industry. The factory is a small shed in which about a dozen men are working, and the value of the outturn is estimated at Rs. 15 a day. The proprietor claims a large amount of credit for having trained his own workmen; but it is doubtful if he has done more than get together a few hereditary artisans and supply them with work. In support of this suggestion it may be mentioned that there is another man making cutlery in the town, but he is not a graduate of the Calcutta University. Some of the articles made in this factory are of excellent quality, and, although the methods of manufacture are primitive, they are not much below the standard which prevailed in the cutlery trade in Sheffield, till more mechanical methods were introduced under pressure of competition from Solingen and America.

India might well be the home of a large cutlery trade, as it is an industry which does not require a very large amount of capital and depends much upon the skill of the artisans engaged in it. There are large numbers of such men scattered all over India, the descendants of the armourers and gunsmiths of the past. The capacity of Mr. Bose's factory could be greatly increased by the installation of a small oil engine to drive the grinding machinery and buffs, whilst light drop hammers might possibly be employed with advantage in forging the knife blades. Mr. Bose is unfortunately very deaf and is far from being a business man; but he is an enthusiastic pioneer, and it is possible that, with some kind of business control, he would do more useful work.

The raw materials used are old files and buffer springs, both of which can be obtained from dealers in old metals at reasonable prices. It would probably require a not very large development of the cutlery trade to exhaust this source of supply; but it should, at no time, be difficult to get cutlery steel of the requisite quality.

THE BENGAL PRESERVING COMPANY, MUZAFFARPUR.

Visited 24th November 1916.

The proprietor of this factory is Babu Basantacharan Sinha, a pleader in Muzaffarpur, who deserves great credit for establishing the fruit canning industry in Bihar and working it up to a profit-earning stage. The Commissioner of Tirhut Division has furnished information regarding the history of this enterprise which need not be repeated. A visit to the factory discloses evidences of its amateur origin. It is badly arranged, and the processes of manufacture are not carried out in suitable buildings. There is not that assurance of scrupulous attention to cleanliness which is essential in a factory

preparing preserved fruits. The proprietor is not a business man and seems to experience unnecessary difficulty in obtaining the credit necessary to carry on this business.

The processes employed are up-to-date, and canned fruits and jams are turned out of excellent quality. At the present time the proprietor is manufacturing largely for British troops in Mesopotamia, and the business is now yielding him good profits. He wants no help from Government, but the stability of the industry would probably be greatly enhanced by the assurance of continued support from the Commissariat branch of the Military Department after the war is over, provided the standard of quality now reached is maintained.

THE SALTPETRE REFINERY, MUZAFFARPUR.

Visited 25th November 1916.

The saltpetre refinery visited by the Commission at Muzaffarpur turns out about 500 tons of refined saltpetre per annum and is said to be one of the largest in the province. The *noomiah* brings crude saltpetre to the factory, and this is dissolved in mother liquor from the crystallising vats and concentrated in large open pans over slow burning fires. The potassium nitrate, being more soluble than sodium chloride, remains in solution and when the sodium chloride has been thrown down, the liquor is drawn off into crystallising troughs. Here it cools very slowly, and the growth of crystals on the surface proceeds rapidly. In about three days all the recoverable saltpetre, due to the difference in solubility of hot and cold solutions, is recovered. The mother liquor is then used to dissolve a further lot of crude saltpetre. All the impurities removed in the processes of refining are heaped together and re-treated at intervals, as, apparently, when mixed with nitrous earth, a further conversion of organic nitrogen into nitric acid takes place.

The factory at Muzaffarpur covers several acres, and at first sight the processes appear to be crude and the methods of manufacture capable of considerable improvement. The labour factor, however, is not important as wages are very low. The recovery of refined saltpetre must, however, be extremely efficient, as whatever comes into the factory remains there and is re-treated at intervals. These saltpetre refineries suffer from the exactions of the petty officials of the Salt Department. From 10 to 20 per cent. of common salt comes in with the potassium nitrate and this can be recovered in apparently a sufficiently pure form to be fit for human consumption. Mr. C. M. Hutchinson, the Imperial Agricultural Bacteriologist, has published a study of the processes employed by the *noomiah* in Bulletin No. 68 of the Agricultural Research Institute, Pusa, and, still earlier, the methods employed in obtaining saltpetre have been described by Messrs. Leather and Mookerjee in Bulletin No. 24 of the same series.

THE TITAGHUR PAPER MILLS, TITAGHUR.

Visited 29th November 1916.

	Rs.
Capital (Paid-up)	25,85,000
Debentures	15,00,000
Block Account	51,07,423
Reserves	24,22,423

These mills are now turning out 1,700 tons of paper a month and employ six Fourdrinier machines. The raw material is *sabai* grass, but wood pulp is also imported from Norway and Japan. Experiments have been made with bamboos with fairly good results. Paper was recently made from 16 tons of bamboos supplied by the Mysore Government from the bamboo jungles in the Shimoga District. At present prices it is doubtful if such a source of supply could be commercially used, even if the bamboos were converted into pulp on the spot.

These paper mills appear to have grown up, and they probably require to be entirely remodelled to obtain the best results. For the past four years they have paid no dividend; but now, owing to the war, they are making a large profit, and their chief difficulty is to get sufficient supplies of grass at remunerative rates.

THE TITAGHUR JUTE MILLS, TITAGHUR.

Visited 29th November 1916.

	£
Capital	300,000
Debentures	98,451
Block Account	803,913
Reserves	468,019
No. of Looms	1,718

These mills were started in 1906 and may be regarded as representative of the industry at the present time. The mills run 13½ hours a day, but the operatives, by an arrangement of shifts, only work two-thirds of that time. A very large number of half-timers, working not more than six hours a day, are employed chiefly in connection with the spinning frames.

The mill stores consumed are worth many lakhs a year and are at present imported. There is no reason, except want of enterprise, why belting, picker bands, pickers and roller leather should not be made in the country. As regards bobbins, it is only necessary to find a suitable wood, obtainable at a reasonable cost, and import the requisite wood-working machinery.

The local housing of the coolies is to be commended, the rent for single rooms being only four annas a week on the ground floor and six annas a week upstairs. These mills are very spaciously planned, and there is no overcrowding.

THE CALCUTTA POTTERY WORKS, CALCUTTA.

Visited 30th November 1916.

This note is based upon the impressions formed during a somewhat hurried visit to these works, and it is possible that the conclusions might be modified by a more detailed study of the problems, the solution of which is essential to the successful development of what is obviously a very promising concern. The pottery, according to the report of Mr. J. G. Cumming published in 1908, is the result of the associated enterprise of the Maharajah of Kasimbazar and Rai Bahadur Baikanta Nath Sen of Berhampore, and it has been in operation for at least ten years.

The capital invested in the concern is stated to be about 2⅓ lakhs of rupees, and the turnover amounted last year to roughly one half this amount, and a profit of 9 per cent. on the whole capital outlay was made. There is no doubt that the outturn, compared with the amount of money invested in the factory, is very low and, since a fair profit has been made on the capital outlay, it is not unreasonable to assume that the prices charged for the manufactured goods are high, and it is possible that there would be a much larger demand if the prices could be lowered.

The manager of the factory, Mr. Deb, has been trained in Japan and Germany, and in the arrangement and lay-out of the plant, which may be described as exceedingly good, he has largely followed German ideas. The equipment of the machinery, so far as it goes, appears to be very complete; but the bulk of it at the time of our visit was not at work. There are three Japanese kilns and one large German kiln divided into three floors. Only one Japanese kiln was under fire, and all the others were empty and cold.

This suggests that the capacity of the factory is considerably in excess of the demand for the goods manufactured, and that more attention should be paid to developing the business in such goods as can be made.

The outturn consists chiefly of ornamental figures and toys which are prepared in a very up-to-date system of plaster moulds. Although one may not admire the taste which creates a demand for such goods, there is no doubt that it has been met with very great technical skill.

Of much greater interest, from a business point of view, is the output of utilitarian articles, chiefly porcelain insulators and fittings for house wiring and insulators for telegraph posts. These seem to be quite satisfactory, and there is a growing demand for the same; but whether this is consequent upon war conditions or whether the articles can really compete in the open market with similar goods, it is difficult to say.

The specimens of common domestic chinaware shown to us disclosed the fact that the technique of their manufacture was imperfect and that a suitable body had not been discovered, as the finish was rough and nearly every article was distorted, consequent upon the high temperature at which they had been fired. It is obvious that more experimental work is necessary to improve the quality of these goods, and it is in this direction that further experimental work should be carried on.

It seems desirable that in the immediate future efforts should be confined to the improvement of the present ware, rather than that attempts should be made to develop business in new directions. The development of the factory will obviously require the further installation of machinery and plant; but there is more than a shadow of doubt as to whether the present manager, Mr. Deb, is capable of solving the difficulties which lie in front of him. He has certainly already displayed so much capacity that one would be inclined to give him a further trial; but it is just possible that he has reached the end of his tether and that any further capital outlay will be ultimately wasted. He seems to be firmly convinced that it is only a little more capital that is required to develop his business; but the amount of capital invested in it already is very considerable and better results both from a business point of view and technically might well be expected before any further additions are made.

THE PEN AND PENCIL FACTORY OF MESSRS. F. N. GOOPTU & CO., CALCUTTA.

Visited 5th December 1916.

This factory is an interesting example of one of the most successful attempts at *swadeshi* enterprise. The capital outlay on buildings and plant exceeds three lakhs of rupees, and there are three complete sets of machinery installed for making (1) lead pencils, (2) pen holders and (3) pens.

No suitable Indian wood has been found for the pencils, and supplies are imported from Mombasa, the wood used being a species of cedar which costs Rs. 275 a ton delivered in Calcutta. The graphite is obtained from Ceylon and is washed and mixed in the factory, three grades of lead being prepared for hard, medium and soft pencils. The machinery used in this part of the factory is of German origin and is not capable of turning out a very highly finished article; nevertheless, with the wood employed, a very satisfactory cheap pencil is produced, which sells now at Rs. 2-4-0 a gross, and at that price it should yield a good profit. The outturn is about 35 gross per day of eight hours, and the demand is considerably in excess of any possible outturn.

The machinery for making pen holders and nibs consists of circular saws for cutting up the wood, of automatic lathes for turning it and of hand presses for metal work. Most of this is of English origin. In addition there are one or two turret lathes and other machine tools for preparing dies, for the manufacture of which the factory is very completely equipped. This is a very satisfactory feature as it renders the factory independent of Europe or America, and should enable it readily to prepare a much greater variety of goods.

The finishing plant, consisting of muffles, annealing furnaces, polishing drums and nickel-plating baths, is very complete. Finally a considerable amount of care has been devoted to packing the goods in an attractive way and in this respect they do not suffer, when compared with imported goods of similar quality.

The factory is now said to be yielding a good profit ; but how much, was not stated. The quality of the work turned out depends less upon the skill of the artisans employed than upon the quality of the machine tools. In this matter, the tool-making department is therefore of the greatest importance, and Mr. Gooptu may be congratulated upon the practical way in which he has recognised this fact. The Bengal workmen do not strike one as particularly skilful in handling the tools. Many of the presses appear to be unnecessarily heavy for the work to be done, and their output is consequently somewhat small.

The weak point in this factory, under war conditions, is that it is entirely dependent upon Europe or America for supplies of suitable raw material in the metal section ; but apparently, so far, no difficulty has been found in this respect.

As already mentioned, the factory only works eight hours a day, and it is difficult to understand why greater advantage is not taken of the present extremely favourable conditions to work at least a double shift and thereby double the outturn.

MESSRS. JESSOP & COMPANY'S IRON WORKS, HOWRAH.

Visited on the 6th December 1916.

The iron works are situated at Howrah on the banks of the Hooghly just to the north of the floating bridge. The company has also carriage and wagon works at Kidderpore. The Howrah shops are laid out to deal with constructional iron work ; but owing to the war, such material is not available in large quantities, and the amount of work of this character in progress was therefore small, and chiefly on Government account for use in Mesopotamia. On the other hand, the abnormal conditions have brought a large amount of work of an unusual character to these shops. 4½ inch steel shells were being drawn in a powerful hydraulic press, and the company was making 100 looms for a jute mill. Other machinery such as small winding engines was also under construction and generally, there was ample evidence of such enterprise as was possible on the part of the firm to deal with an extremely difficult situation. In general terms, the shops may be described as up-to-date and adequately equipped with sufficient tools and plant.

THE BENGAL NATIONAL TANNERY, CALCUTTA.

Visited 12th December 1916.

This tannery is the private property of the Hon'ble Dr. Nil Ratan Sircar and is situated at Balinghata on the outskirts of Calcutta. The manager of the tannery, Mr. B. M. Das, was sent to England with a University scholarship and studied for two years at Leeds University, subsequently working in a tinctorial laboratory in Germany and at a tannery in Italy.

The tannery is mainly devoted to the manufacture of chrome upper leathers ; but bark tanning is also done on a limited scale, splits being so treated and also sole leather. Attached to the tannery is a boot factory provided with a considerable number of machines. Dr. Sircar states that from first to last he has spent about two lakhs of rupees on this tannery and that it now yields him about five per cent on his capital outlay, the outturn of the factory being worth approximately Rs. 20,000 a month.

Leather of very good quality is turned out, and the boots, shoes and slippers may be described as good country-made articles, that is to say, they are strong and durable but lack finish. The workmen are principally Chamars ; but there are also some caste people employed. The machinery is of a good class, and the tanning drums are well made, though of local manufacture. The

engineering part of the work is not of a high order, and the tanning drums are run at an unnecessarily high speed. It is understood that Dr. Sircar ventured upon this business purely from patriotic motives, and it is perhaps a pity that besides attempting to demonstrate the feasibility of starting chrome tanning in Bengal, he should not have been equally keen on showing that he could make money. That he has obtained his main object, there can be no doubt; but the profit obtained on the turnover is much less than might have been reasonably expected. About 20 per cent of the leather made in the tannery is used in the boot factory, and it may be suggested that much better results would have been obtained by employing the capital invested in the boot factory on developing the tannery. Without a detailed examination of the accounts, it is of course impossible to say whether both branches of the business have been worked at a profit or whether one branch is absorbing the profits made in the other. It does not follow because a man is a successful tanner and has a good commercial knowledge of the business that he will be equally successful in the manufacture of boots and shoes. These trades are quite separate, and it is distinctly unfortunate that in India chrome tanners should have blindly followed the procedure which was originally adopted in Madras. There, where the industry was first started, it was absolutely essential to open a department for the manufacture of goods from the leather turned out by the tannery. At that time, Indian chrome leather was either unknown or was viewed with great suspicion by manufacturers of leather goods, and it was necessary to demonstrate the suitability of chrome-tanned leather for Indian requirements. The need for such no longer exists, and tanneries and boot factories should be separate commercial undertakings. Specialisation is essential if Indian factories are to compete in the open markets of the world, and the sooner this is recognised the more rapid progress will be.

From his previous history; it may be assumed that Mr. Das is a scientific tanner and is a master of the trade; but it is doubtful if he is equally conversant with the manufacture of boots and shoes.

The Members of the Commission have now visited three factories in Calcutta, the products of the swadeshi movement. These are the Calcutta Porcelain Factory, the Pen and Pencil Factory belonging to Mr. P. N. Gooptu and the National Tannery. All three have entered the profit earning stage. Each is unquestionably open to considerable criticism, either in regard to the quality of the work turned out or the business management; but each may be regarded as a promising industrial concern. The success so far achieved should afford ample encouragement for the development of these enterprises; but that development should be in the direction of increased specialisation and the tendency to diffuse efforts over a wider field should be sternly resisted.

SCHOOL OF HANDICRAFTS, NAGPUR.

Visited 15th December 1916.

This is a rather unique type of industrial School, the aims and objects of which are fully described in the prospectus furnished to the Members of the Commission who visited the School and supplemented by the evidence tendered by the superintendent, Mr. E. Cove.

The School proper contains two departments, one devoted to carpentry and the other to blacksmith's work with a little turning and fitting. All pupils of the School must be the sons of artisans and in granting admission, preference is given to boys coming from villages. The course of instruction was originally three years, but has now been reduced to two years, and the age limit of admission raised to 16. The work done by the boys in the School is extremely good and is evidence of the efficiency of the instruction. There can be no doubt that the policy of restricting admissions to the sons of artisans is thoroughly sound; but it is questionable whether the training given in the School goes far enough and deep enough to turn out a really good class of superior artisan. It seems improbable that the village carpenters will go back to village life and

that if they want to utilise their superior attainments, they will have to find employment in towns or cities, where there is a demand for carpentry and cabinet work. On the other hand, with the development of rural engineering, which is in progress in the Central Provinces, there should, in the future, be a considerable field for the employment of skilled mechanics to look after agricultural machinery and keep in repair the modern types of agricultural appliances, the use of which is gradually spreading over the country. To supply this prospective need, it would seem that the course of instruction should be considerably extended, so as to provide for more time on fitting work and for detailed instruction in the practical running of oil engines and the various simple machines which are usually driven by these prime-movers.

The boys in both these classes get scholarships of Rs. 8 for the first year and Rs. 9 for the second, and, when they leave the School, they are provided with a small outfit of tools to enable them to start work in the way they have been trained.

Besides these two classes, an experienced boot-maker has been entertained who gives instruction to *moochies*. A room is provided in the School in which the *moochies* work and they are employed in executing orders received by the superintendent of the School. They get no regular pay; but the profits arising from the sale of goods manufactured are divided amongst them. The work turned out is of very good quality and meets with a ready demand, and the *moochies* actually receive very good wages.

The class is a highly practical one, and the Commission noted with interest the recent developments, the results of which should prove of great interest. As an example, the Commission saw four of the *moochies* who had worked in this trade class and who have joined together and rented a small building, in which they have started a workshop giving employment to some 15 or 20 workmen of their own caste. Through the good offices of the superintendent of the School, they have been able to take contracts for large numbers of ammunition boots, and the superintendent has advanced to them sufficient money to enable this to be done. Whether the scheme will prove a success or not probably depends largely upon the character of these *moochies*. If they work in harmony and turn out honest straightforward work and do not get into difficulties with their employés, they should become master-workmen of a very superior character. It is asking, however, a good deal from men of this type, and there is more than a chance that either the venture will make an undue demand on the time of the superintendent of the School or that it will not prove the success anticipated.

This School of Handicrafts has made an exceedingly good start, and further developments are contemplated. Whether the proposed developments are exactly on the lines best calculated to advance the industrial prosperity of the province is open to some doubt, and it seems desirable that the probable future needs of the Agricultural Department especially should receive careful attention.

THE KATNI CEMENT WORKS, KATNI.

Visited 20th December 1916.

Conditions in the neighbourhood of Katni are extremely favourable for the manufacture of Portland cement. Both limestone and clay of suitable quality are in extreme abundance, and coal can be obtained from Bengal at a moderate cost. The factory is situated about two miles from Katni, in the neighbourhood of the clay beds. There are limestone quarries near by, and limestone containing about 92 per cent. of carbonate of lime is brought in by railway from Sutna.

The cement works are of a very modern type, the plant being manufactured by Messrs. Schmidt & Co., of Copenhagen. Briefly, the process employed in the works is as follows:

The limestone is first reduced to about the size of road metal in a stone-crushing machine, after which it is elevated to a ball mill, where it is reduced to a

fine powder. It is then mixed with clay to reduce the proportion of carbonate of lime to 72 per cent., and the mixture is further ground in a tube mill. The slurry thus prepared is stored in large cement tanks and kept in a continual state of agitation by revolving paddles. From these tanks the slurry is pumped into a revolving kiln 150 feet long, fired at the lower end with powdered coal dust. The wet slurry enters the kiln and passes through it in the course of about four hours, being first dried, and then deprived of the carbon dioxide, and finally converted into clinker. The hot cement is cooled by large volumes of cold air passing over it as it is carried through a closed inclined cylinder. The cool clinker is ground in a ball mill and finally in a tube mill. To the clinker is mixed a certain percentage of gypsum to regulate the setting time of the cement.

A somewhat similar plant to that used for grinding the cement is employed to prepare the very fine coal dust which is blown into the revolving kiln by compressed air and by the combustion of which an intensely hot and very long flame is produced.

For the supply of power, there is a separate power house containing three Babcock and Wilcox boilers supplying steam to two turbines direct coupled to dynamos of 550 k. w. capacity each.

The amount of labour employed in the cement factory is very small owing to the automatic character of the plant; but the arrangements for bagging the cement are primitive and not in keeping with the rest of the factory. The staff consists of a manager, an engineer and a chemist, with one European foreman.

Owing to the war, the factory is not only realising very high prices for its cement but it can sell its whole output, and it is now being worked at its maximum capacity, which is about 3,500 tons a month. The work is carried on continuously, and the running time averages about 29 days in a month.

Situated on the East Indian Railway, midway between Bombay and Calcutta, the question of railway freights is extremely important, if the factory is to compete with imported cement in either of these cities in normal times. Imported cement is usually packed in casks, but in this factory the cement is only packed in jute bags, which are not quite so convenient for transport and storage.

The favourable conjunction of raw materials should reduce the cost of manufacture to a very low figure. It therefore seems reasonable to expect that in the future the output of cement from the Katni district will be greatly increased either by the extension of the present plant or by the establishment of other similar plants owned by private companies.

Attached to the cement factory is a pottery and tile works, where drain pipes, roofing tiles and bricks are made. This seems to be an example of the Indian tendency to diffuse efforts over too wide a sphere. The development of the cement industry was surely enough for this one company to undertake; but apparently, they have saddled themselves with a not very promising pottery.

This factory is a good example of what can be done by capital, enterprise and good management. It was established just before the war broke out, and consequently its promoters are now reaping a golden harvest; but even at pre-war rates, the success of the industry is amply assured.

THE POTTERY WORKS OF MESSRS. BURN & CO., JUBBULPORE.

Visited 21st December 1916.

These works have been in existence for a long time and have been gradually extended to meet the growing requirements of the country in regard to salt-glazed stoneware pipes and sanitary ware. The clays in the neighbourhood of Jubbulpore are eminently suitable for this class of work; but apparently so far there has been little or no inducement to take up higher classes of work. The result is that the factory is to a large extent dependent upon occasional big orders received from towns and municipalities, when they put in a drainage

system. Practical experience has demonstrated that at Jubbulpore such wares as those turned out in this pottery are equal in quality to the imported goods. The high cost of freight on stoneware pipes militates to a great extent against their employment for miscellaneous purposes, and attempts have been made in various localities to substitute for them, without any great measure of success, cement pipes made locally. The factory is well equipped with modern machinery of the class suited for the manufacturing work carried on; but the developments added from time to time have resulted in a general arrangement of the plant, which is probably not conducive to the most efficient working.

THE GUN CARRIAGE FACTORY, JUBBULPORE.

Visited 22nd December 1916.

This is a modern Ordnance factory erected within the last ten years and equipped with up-to-date machinery of a very efficient type. It supplies the whole requirements of the Indian army in regard to gun carriages, and at the time of our visit was working under war conditions, with the output greatly increased above the normal in peace times.

The most notable feature in the factory was the arrangement of the wood-working machinery, whereby all overhead shafting and belting was dispensed with. This factory may be regarded as an excellent example of what can be done in India with Indian workmen in a well-organised factory under competent expert management.

THE BENGAL IRON AND STEEL Co., LTD.

BARAKAR IRON WORKS.

Visited 6th January 1917.

These works were originally established in 1875 by the Barakar Iron Works Company, Limited, but proved a failure and were closed in 1879. About two years later, Government acquired the plans and restarted the works and ran them for about 8½ years, when they were transferred to the present company. At that time, the plant consisted of two small open-top furnaces, only one of which was worked, and the production of pig iron in 1889-90 was 9,000 tons, of which about 3,800 tons were used in the foundry. A considerable amount of money was expended in remodelling the plant. A new blast furnace was installed with Cowper stoves, and the two existing furnaces were remodelled and fitted with closed tops to enable the furnace gases to be utilised. These improvements were followed by an expansion of the output; but the company did not prosper, and the quality of the output was by no means satisfactory.

In 1894, Messrs. Martin & Co., of Calcutta were appointed managing agents, and in the following year the Government of India contracted to take 10,000 tons of pig iron or castings per annum for a period of ten years at prices five per cent under the cost of equivalent imported material.

The following table shows the financial results achieved by the company from 1895 onwards.

Year ends in September.

		£			£
1895	Loss	10,961	1907	Profit	35,423
1896	"	9,520	1908	"	20,622
1899	Profit	1,306	1909	"	6,956
1901	"	29,863	1910	"	1,414
1902	"	26,324	1911	"	32,127
1903	"	22,052	1912	"	42,721
1904	"	12,363	1913	"	8,000
1905	"	9,009	1914	"	68,000
1906	"	5,564	1915	"	125,000

The year 1910 was notable in the history of the company. In August of that year they commenced to draw their supplies of ore from Manharpur.

This ore yields 62 per cent. of iron, and from it pig can be made containing from 0·15 to 0·25 per cent. of phosphorus. If this ore had been available earlier, it is possible that the steel-making venture of the company, entered into some years previously, would have had a very different result.

About 1903, the company decided to embark on the manufacture of steel, and 17½ lakhs of rupees were invested in a steel-making plant, which ran from June 1905 till January 1906, during which time 5½ lakhs of rupees were lost. Two open-hearth furnaces were set up and a rolling mill erected, capable of turning out joists 6 inches by 3 inches and other sections of equivalent size, including rails up to 50 pounds in weight.

The Government of India gave the company a subsidy of £1,500 a year and authorised the officers of the Public Works Department to purchase such material as they required from the company at current market rates; but a reduction of Rs. 3 a ton was to be made on every ton supplied as a set-off against the subsidy of £1,500. In effect, the Government assistance resulted in 136 orders for 360 tons of steel of 68 different sections.

At the time the mill was started, imported steel could be obtained at Rs. 4-8-0 per cwt., and the company soon found that it had been extremely ill advised regarding the prospects of producing steel cheaply from the pig iron at their disposal. This iron contained as much as one per cent. of phosphorus which, it was found, could only be eliminated by very prolonged heating of each charge, accompanied by excessive wear of the lining of the furnaces. The heat, which it was expected would have been worked off in eight hours, took as long as thirty hours. The cost of working, as compared with what it would be to-day, was further increased by the fact that all fire-bricks had to be imported from England and that ferro-manganese was not made in the country.

The excellent results obtained from Manharpur ore enabled the company practically to remodel and extend their works, which are now of a modern character and capable of producing pig iron very cheaply. There are now four blast furnaces, all of the same type and each capable of an outturn of about 80 tons of pig per day. This may be considered small in reference to ordinary American practice and to the most recent developments in England; but the advantages to be gained by the adoption of a larger type of furnace would certainly not have compensated for scrapping so large an amount of valuable plant. The fourth furnace was blown in a year ago and was erected after a careful consideration of the problem. The furnaces are each 55 feet high and are supplied with hot blast from 13 Cowper stoves, 10 of which are 65 feet high and 21 feet in diameter, whilst the other three are 55 feet high and 17 feet in diameter. Formerly, the blast was supplied by three vertical blowing engines, two of which have been discarded and the third is only used as a stand-by to two Parson's steam turbines and rotary blowers of a combined capacity of about 5,000 h. p. The steam is generated in boilers fired by the waste gases from the furnaces.

For the production of one ton of pig iron, 32 cwts. of ore, 8 cwts. of limestone and 26 cwts. of coke are required. As already mentioned, the iron ore is obtained from the company's mines at Manharpur which are connected with the Bengal Nagpur Railway by a light railway 16 miles in length. The lead to the furnaces is about 150 miles, and the cost of the ore delivered is about Rs. 4 a ton. Lime is obtained from Sutna, a distance of 450 miles, and from Kharsia, a distance of about 200 miles. About half the coke required for the furnaces is made on the spot and the balance purchased locally. The coking plant consists of 68 Simon-Carvee coke ovens arranged in two banks and fitted with a plant for the recovery of tar and ammonia, the latter in the form of ammonium sulphate, of which about 20 pounds is obtained per ton of coal coked. Sulphuric acid is made on the premises, and the monthly output of ammonium sulphate is 95 tons.

The output of pig iron is now about 10,000 tons per month, the bulk of which finds a market not only in India but also in Japan, Australia, New Zealand, China and South Africa; on occasions it has been exported to Italy and South America; the remainder, about 3,500 tons is used in the foundry,

where heavy castings are made, chiefly of pipes up to 12 inches diameter, bends of all kinds, columns, fencing sockets, pot sleepers and chairs. The foundry is now capable of turning out castings up to 20 tons in weight. As examples of work just completed, mention may be made of a pot still weighing 10 tons and an anvil block weighing 15 tons.

The foundries, of which there are three main sections, are well laid out and provided with ample crane facilities for handling a large and heavy turnover. As adjuncts to these, there is an extensive range of machine shops, patterns shops, a brass foundry and a smithy, all well equipped with modern machine tools.

The capital of the company is £575,000 divided into, ordinary shares £225,000, six per cent preference shares £150,000, and five per cent debentures £200,000. The dividend for the year ending September 1915 was 24 per cent.

The Bengal Iron & Steel Company now employs, including the men working at the mines, about 10,000 men and the wage bill amounts to approximately Rs. 1,30,000 a month. The work is supervised by about 65 covenanted Europeans, the majority of whom are paid from Rs. 300 to Rs. 500 a month.

These Iron Works, as will be seen from the foregoing narrative, have had a very chequered career. Rule of thumb seems to have predominated in the earlier years of the management, and the magnificent success now achieved is entirely due to a combination of scientific methods with business organisation, helped greatly by the discovery and opening out of the very rich ore bed now being worked.

KUMARDHUBI ENGINEERING WORKS, LTD.

Visited 6th January 1917.

The Commission visited the Kumardhubi Engineering Works belonging to Messrs. Bird & Co. These works are now undergoing complete reconstruction and are intended chiefly to deal with the engineering requirements of the coal fields. The work turned out approximates to thirty lakhs of rupees a year and consists chiefly of colliery plant, including winding engines and hoists, wire ropeways and staiths for handling coal. On the edge of an old open coal working, which now forms a tank about 100 feet deep, a central power station has been erected equipped with two Babcock & Wilcox boilers, each generating about 400 h. p. and supplying two Belliss & Morcombe steam engines driving Siemen's dynamos. Three-phase current is generated at 500 volts and transformed for distant transmission to 6,000 volts. The estimated cost of the power plant is £20,000 and the cost of reconstruction of the workshops £40,000. The power station was at work, although the condensing plant had not been completed. The construction of the new workshops and the manufacturing operations were going on simultaneously, and the adaptability of electric power transmission was well illustrated.

KUMARDHUBI FIRE CLAY & SILICA WORKS, LTD.

Visited 5th January 1917.

Under the same management and situated less than half a mile away are the Kumardhubi Fire Clay & Silica Brick Works. On these, an outlay of about six lakhs of rupees has been incurred, and they are entirely engaged in the manufacture of the requirements of metallurgical furnaces and coke ovens, such as magnesite bricks, silica bricks and a high grade of ordinary fire-bricks. There is a good local clay for the fire-bricks, and quartz rock fit for silica bricks is found at no great distance, but the magnesite has to be brought from Mysore. The factory is well equipped with the usual grinding, crushing and mixing machinery and is provided with a brick-making plant.

The kilns are circular, working on the down-draught system and arranged in sets of four round a central chimney. The drying sheds are extensive. Only material of the very highest quality which it is possible to produce in India is manufactured, and the magnesite bricks are equal to those imported.

whilst the life of the silica bricks is within ten per cent. of the life of the highest grade obtainable from Europe. With this the management are not satisfied and they are seeking expert assistance in the hope that they will be able to improve the quality of their present outturn.

THE TATA IRON AND STEEL COMPANY, SAKCHI.

Visited 7th and 8th January 1917.

These steel works, designed and erected by Americans, possess the characteristic features of American practice—a large output and the application of labour-saving machinery to the utmost extent possible. There has been no growth or development; as they stand to-day, so they were originally designed. A good lay-out was therefore possible, and the conditions were favourable for reducing the cost of handling the immense mass of material involved in the production of 600 tons of pig iron and 300 tons of rolled steel per day.

The smelting plant consists of two blast furnaces, the first of which was blown in in December 1911 and shut down in September 1916 for relining. The second furnace was blown in in September 1912 and is still running. For their size, the output is large, as the ores employed are rich and easily smelted. A typical charge may be taken as 1 ton of ore, 1½ tons of coke, half a ton of dolomite and 70 to 80 pounds of manganese ore. From this one ton of pig iron will be produced. The original furnace still running yields an average of 270 tons of pig per day, whilst in the re-lined furnace, in which certain alterations have been made, the capacity has been increased to 320 tons a day. When working to produce ferro-manganese, which involves a very much heavier burden, the output averages about 50 tons a day and has not been forced beyond 75 tons. Owing to the ore containing about 8 per cent. of iron, it is not possible to produce a very high grade of ferro-manganese, and 73 per cent. manganese may be taken as the normal quality.

The blast furnaces require about 800 tons of coke a day. At the outset, it was decided that it would not be worth while to instal by-product recovery ovens, a decision which has since been regretted. At the present time, there are 50 Kopper recovery ovens and 180 Coppee coke ovens. Beehive coke ovens were also used for a time; but they are now discarded.

The company have invested upwards of 60 lakhs of rupees in suitable coalfields in the Bengal area and they are at present raising about 10,000 tons of coal a month, which will be gradually increased. Their policy is to sell all the first-class coal and purchase as much dust as possible for their coke ovens, utilising the second class coal for the generation of steam.

The Kopper coke ovens are fitted with a plant for the recovery of tar and ammonia. The former is slightly under 3 per cent. and the latter 1·1 per cent on the weight of coal coked. A very complete sulphuric acid plant of modern design is an essential feature of the scheme.

The furnaces are worked at a pressure of from 12 to 14 pounds per square inch, and the blast is supplied by three steam turbines and rotary blowers, each of a capacity of about 2,500 h. p. In the same building is installed the electric generating plant which has a capacity of about 4,000 k. w. The turbines and blowers are of the Zoelly type made by Escher Wyss & Co. of Zurich.

The steel works are adjacent to the cupolas, and that part of the output which is to be converted into steel is stored in a 300 ton tank. There are four steel furnaces of from 45 to 50 ton capacity and the present output of steel is about 11,000 tons a month. To work off a heat takes on an average 8 hours. To start with the charge usually consists of 70 per cent. of pig, 9 per cent. of ore and 21 per cent. of scrap; but large additions are made during the progress of the heat which reduces the pig in the final product to about 60 per cent. 112 tons put in the furnace produce 100 tons of steel in the form of ingots, and 135 tons of ingots are necessary for the production of 100 tons of rolled steel. It therefore follows that 90 tons of pig are required for the production of 100 tons of finished steel.

The steel tapped from the furnaces is cast into ingots weighing up to 52 cwts. These are transferred as soon as possible to the soaking pits, where they are prepared for the rolling mill. This part of the equipment consists of a bloom mill for roughing down the ingots and a 28 inch mill for rails. There are also three bar mills, one of 16 inch, one of 10 inch and one of still smaller size. The output of finished steel is about 300 tons a day. The steel works require a higher class of labour than is necessary for working the blast furnaces, and it is satisfactory to note that, both at the open hearths and the plate mills, no serious difficulty has been experienced in training a sufficient number of men to carry on the work.

The Government of India are under contract to take 20,000 tons of steel rails annually from the company, and the arrangements for the inspection and testing of these are very complete. Owing to the war and the partial isolation of India from Europe in the matter of supplies, these steel works have proved a national asset of enormous value.

How these steel works came into existence is a fascinating story of commercial enterprise of the very highest type. The late Mr. Tata, at the outset, did not contemplate operating on the scale which was finally adopted, and he seems to have directed his attention to the iron ore deposits of the Chanda district in the Central Provinces. Investigations showed that the ores available were of insufficient extent to form the basis of an iron industry, and attention was then directed to Dhulli-Rajara which had lately been brought to notice by the Geological Survey Department. Still later, the Raja of Mourbhanj drew the attention of the firm to the deposits of iron ore at Gurumasini within the limits of his State. In the early investigations it had been settled that the location of the works might be anywhere between the sources of supply of fuel and the ore beds. Roughly, equal weights of ore and coal were required to form the burden of the furnaces and it mattered little whether the ore was brought to the coal or the coal to the ore. The principal point was to get the two in as close proximity as possible, leaving the site of operations to be determined by other considerations. Coking coal could only be obtained in Bengal, chiefly on the Jherria field, and the discovery of the Gurumasini iron ores greatly improved the prospects of the undertaking. The final selection of Sakchi as the site for the works was determined by its proximity to the Subarnarekha river and to the Bengal-Nagpur Railway main line at Kalimuti. A good supply of water, excellent foundations and sand in abundance, suitable for the work, combined to render the site almost an ideal one. The coal comes from the Jherria coal fields, either in the form of coke or coal dust, the ore from Gurumasini, to which a branch line 37 miles long has been constructed, and the dolomite from Panposh, a distance of about 100 miles. For the steel furnaces lime is essential, and the lime stone is at present obtained from Katni; but suitable deposits have been acquired at Sakti within 200 miles of the works.

The extreme care with which the preliminaries were worked out has resulted in the selection of a site where raw materials can be assembled under extremely favourable terms, and this is reflected in the working of the company which is now able to produce pig iron for a working cost of Rs. 16-10-0 a ton, though the average since the commencement of working is about Rs. 20 a ton. Not only is the iron produced extremely cheaply, but it is a metal of excellent quality as is evidenced by the fact that it is in large demand all over the East.

The steel plant was first worked at the end of 1912; but trouble was experienced owing to the design of the open-hearth furnace not being suited to the character of the local materials. The most experienced technical skill available was concentrated on the difficulty which was successfully overcome, though only after incurring losses which would have proved fatal to a small scale enterprise. The wisdom, therefore, of starting on what was for India an unprecedented scale of industrial working, was fully justified.

Evidence has been placed before the Commission by Mr. Tutwiler regarding the labour employed, which need not here be repeated. At the outset, a very large amount of imported labour was necessary and, as the blast furnaces were of American design, American workmen were imported to run them. Similarly,

the open-hearth furnaces followed the German practice and were, at the outset, operated by Germans, whilst the coke ovens, although of Belgian origin, were placed in charge of men from Great Britain.

When the rolling mill was first started at the end of 1912, British labour was employed, the superintendent being paid as much as Rs. 1,800 a month. The management has always been in the hands of experienced American experts, as it was found impracticable to get men from Great Britain, and it may be of interest to place on record the fact that the present general manager joined the company only five years ago in a comparatively subordinate position. His present salary is Rs. 3,500 a month, and on the result of the last year's working he received a bonus of Rs. 10,000. Approximately, his present remuneration may be estimated to amount to not less than Rs. 6,000 a month.

Very large extensions of the works are contemplated involving an expenditure of 4½* crores of rupees, and the services of Mr. Perin, who since 1902 has been the consulting engineer of the company, have now been secured as a whole-time officer of the company.

The plant as it exists was designed by Messrs. Kennedy & Saline of New York, and their fees amounted to approximately £50,000. Large ideas have throughout prevailed in the development of this enterprise. What the financial results would have been in normal times, it is hardly worth while to discuss. The outbreak of war was followed by a period of depression; but gradually the industrial resources of the British Empire were mobilised for the struggle, and the capacity of these steel works has been fully utilised.

At Sakchi, about 11,000 workmen are employed by the company, and in addition there are 2,000 men under the contractors, making a total labour force of 13,000 men, whose wages amount to two lakhs of rupees a month. The town of Sakchi now contains 50,000 inhabitants. Three lakhs of rupees have been expended on a drainage scheme, and a pumping plant has been erected on the Subarnarekha river, capable of supplying eight million gallons of water a day for the use of the works and the town. What may be termed a garden city has been laid out and suitable residences for all classes of employés have been built, including cooly lines for about one thousand of the lowest paid class of workmen employed, and further extensions in this direction have been sanctioned. The social welfare of the employés of this enterprise has received noteworthy consideration, and there are two institutes which are practically social clubs. A primary school, an elementary technical school, and night classes are held for the instruction of the men employed in the works.

The directors acknowledge the help they have received from Government, chiefly through the Geological Survey, whose advice on technical matters has determined the attitude of the Government of India and the nature of the concessions which have been granted from time to time to the company, to enable it to place the enterprise on a thoroughly sound basis.

The company is in actual possession of five square miles round Sakchi and has an option for a further 15 square miles belonging to the Dalbhoom Syndicate. It has mining rights over sufficiently large beds of ore at Chanda, Dhulli-Rajara and Gurumasini to relegate to a very distant future any anxieties regarding the supplies of ore. Its proximity to the Bengal coal fields ensures a supply of fuel, and adequate supplies of fluxing materials are in sight with a prospect of a further development of resources in this direction.

The present output of steel, as already stated, is 300 tons per day, which it is proposed ultimately to increase to 1,500 tons, which is about one-third of the present requirements of the country.

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*Note.—The above was written in January 1917. The estimate of the extensions now (July 1918) under contemplation comes to Rs. 12½ crores.

THE IRON WORKS OF MESSRS. BURN & CO., HOWRAH.

Visited 12th January 1917.

These iron works are very conveniently situated on the Hooghly, a short distance below the Howrah bridge, and the yards have been laid out to take advantage of the river front.

The business of the company is mainly under four heads:—

(1) The construction of river craft, such as stern-wheel steamers of light draught, steam paraffin or petrol launches, barges and flats. At the time of the visit of the Commission, the only work going on was for the Military Department for despatch to Mesopotamia. The company are prepared to undertake the construction of sea-going boats up to 3,000 tons capacity and of a length of 350 feet.

(2) Constructional iron work. The facilities for dealing with this are considerable and were planned about 14 years ago, so that they are of a modern type and capable of handling large quantities of material cheaply and with despatch.

(3) Carriage and wagon construction. With the exception of axles, wheels and tyres, railway rolling stock can be completely constructed in these works. For light, narrow gauge railways, chilled iron wheels are made; but wheels requiring tyres are imported.

(4) Machine construction. Recently the machine shops have been mainly occupied with the manufacture of 4·5 inch shells, of which 34,000 have been made. For this work, a specially heavy hydraulic press was constructed by the company; but the work has now ceased, as, with the enormous development of shell factories at home, an output of 2,000 4·5 inch shells per week was regarded as such a small contribution that it did not appear worth while to divert plant from other purposes. The workshops can be more usefully employed in attending to the increasingly urgent requisitions of normal industrial enterprise. Fourteen sets of engines for the various types of river craft under construction in the yard were in hand, the largest of these being capable of indicating 400 h. p.

In addition to carrying on the manufacturing work described above, the company are agents for many firms who make special machinery at home, and an important part of their business is importing the same and arranging for its erection. They have a license to manufacture the Humphrey Gas Pump and have recently made several for the Madras Corporation to be used in pumping sewage.

The equipment of the works is of an unequal character in the different departments. Notably, in respect to wood-working machinery, it is of a very primitive character. Logs were being reduced to scantlings by hand sawyers. The general impression created is that, whilst the firm has a large and miscellaneous business, it is not abreast with modern developments. The capital of the company is 21 lakhs in ordinary shares, and Rs. 15,72,000 in debentures.

MESSRS. D. WALDIE & CO., AND THE BENGAL DISTILLERIES LIMITED, KONNAGAR.

Visited 19th January 1917.

These works look as though they have had their day, and the management appears to be desponding and unenterprising. The principal feature of the factory is an antiquated sulphuric acid plant of a type by no means efficient. There are six lead chambers but no Gay Lussac or Glover's Tower, and the waste of nitric acid must be considerable. Part of the acid manufacture is sold as such and is concentrated in glass, but a considerable proportion is used in the works for the manufacture of sulphates of aluminium, iron and magnesium. The alumina is obtained from bauxite procured from the Central Provinces, and the magnesite used in the works is brought from the Salem District of the Madras

Presidency. The output of magnesium sulphate is about ten tons a month Nitric acid and hydrochloric acid are also manufactured.

Adjoining the chemical works and under the same management, but belonging to a separate company, is a small distillery in which country spirit is made from *mahua* and Java molasses. There are two stills, one an ordinary Coffey still and the other a patent French still, which yield unsatisfactory results. The output of proof spirit is 10,000 gallons a month.

Attached to the distillery is a bonded laboratory in which alcohol of high strength is prepared and, on a small scale, pharmaceutical preparations involving the use of spirit are manufactured. Most of these are vegetable extracts prepared from raw materials imported.

Messrs. D. Waldie & Co. have recently taken up the manufacture of potassium bichromate from chromate ores obtained from Baluchistan, but this work is being done in a branch factory elsewhere and has been assisted by grants from the Department of Industries in Cawnpore.

The management complain that their sphere of operations is greatly restricted by the high price of sulphur for which they have now to pay over Rs. 200 a ton. They have made no attempts to use any of the immense variety of drug-yielding plants which can be grown in India. They stated that they are also greatly handicapped by the difficulty in getting stoneware jars in which to pack their various productions, that Messrs. Burn & Co. decline to take up their manufacture at Raniganj, and that an order placed with the Perfect Pottery Company, Jubbulpore, for 400 jars a month was only in part executed, and that the jars supplied were so imperfectly glazed at the bottom that the contents leaked in course of transit. Apparently, for the present, they are depending upon supplies from Messrs. Parry & Co., at Ranipet in the Madras Presidency.

Another difficulty is the high cost of soda. Some half-hearted attempts have apparently been made to extract this compound from the *usar* soils of Northern India, but with no practical result. For the retail supply of chemicals, glass bottles are also required in large quantities. The failure of the various attempts to establish the glass industry on the Hooghly has doubtless retarded the development of these local works.

THE GOVERNMENT CENTRAL WEAVING INSTITUTE, SERAMPORE.

Visited 13th January 1917.

This weaving school was started in 1909 and from the outset has been in charge of Mr. Hoogewerf, one of the earliest of the Government of India scholars. He has tendered evidence to the Commission and was examined at some length.

The school is situated in an old building at Serampore which is not particularly well adapted for the purpose. There are two classes of students; one, artisans of the weaving community who come to the Institute to be put through a course of instruction in the use of the fly-shuttle loom. They then return to their villages and are supposed to set up as fly-shuttle loom weavers. Whether they do so or not is uncertain as the Principal states that he has no time for inspection work in the districts. The other class is composed of fairly well educated young men who are put through a complete course of technical instruction in weaving, so that afterwards they may become master weavers controlling small hand-loom factories or teachers in industrial schools. The course of instruction extends over two years and is of a somewhat elaborate character.

The school is well equipped with pit looms, frame looms and special types of looms such as that brought out by the Salvation Army and the Hattersley pedal loom. Dobbies are freely used for simple ornamental borders and there are one or two small jacquard machines for more intricate patterns. There are several types of warping mill and some of Hattersley's pirn and bobbin winders

The school is popular, as at the present time there are 47 students in the higher class and 56 in the artisan class, the vast majority of whom receive stipends or scholarships.

The expenditure on the school last year was slightly over Rs. 26,000. A record is maintained of the subsequent careers of students who have passed out of the school; but the record is a very imperfect one and affords very little information on which to base an opinion as to the practical results achieved from the course of training. The average cost to Government of each student trained in the school is about Rs. 260 a year, and in addition to this must be included the value of scholarships and stipends derived from outside sources. Each student has to purchase raw material with which to practise, and is allowed to take away such cloth as he is able to make.

The Principal has a high opinion of the utility of the Hattersley's pedal loom, which is directly contrary to South Indian experience. He, however, confirms South Indian experience in regard to the inutility of the Salvation Army loom; but he has refrained from discarding them, apparently because they were recommended to the Government of Bengal by Commissioner Booth Tucker.

The Commission were informed by the Principal that about 15 hand-loom factories had been started in Bengal by the passed students of the school; but he had absolutely no information as to whether they had proved successful or not. He has promised to collect this information and to submit the same as early as possible.

There is no conclusive evidence that the school is effecting any material improvement in the condition of the hand weavers of Bengal. The Principal has undoubtedly a good knowledge of the technique of hand-loom weaving; but he has altogether neglected the economics of the industry and it is, at the present time, probable that an improvement in the organisation for marketing goods is of much greater importance than the introduction of improved technical processes. Experience elsewhere in India shows that where the weavers have a free market for their goods, there is not the slightest difficulty in getting them to adopt any machinery which will help them to increase their productive power.

THE ORDNANCE FACTORIES, COSSIPORE AND ISHAPUR.

Visited 15th January 1917.

Of these two factories, that at Cossipore was started as early as 1802, and when the time came for large extensions, it was found that the land in the neighbourhood was so valuable that it was preferable to go up the river 14 miles to Ishapur.

Ishapur.—The principal feature of this factory is the steel-making plant, consisting of two 12-ton furnaces designed to produce acid steel of fairly high carbon content from imported pig, containing a very low percentage of phosphorus. The cast steel ingots are reduced to the requisite sections necessary for the work of the factory in a rolling mill of more than sufficient capacity to deal with the output of the furnaces. The officers of the factory state that basic steel is not suited for guns, and that acid steel is greatly preferred for shells.

At the time of our visit, only one furnace was working, as the other had recently burnt through and was under reconstruction. The rollers for the mills are made in the factory—those of very heavy sections from cast iron and the lighter ones from cast steel. In the latter case, to ensure thoroughly sound castings, very large headers are employed. The plant for making shells, both high explosive and shrapnel, is of considerable capacity and recently, working double shifts, as many as 50,000 have been turned out in a month. The shells are forged or drawn in hydraulic presses, and there is a very large hydraulic pumping station, supplying water at both 700 and 3,000 pounds pressure per square inch. After the shells have been forged and drawn in the hydraulic presses, they are rough-turned and then despatched to Cossipore to be finished.

The section of the factory devoted to the manufacture of cartridge cases and fuse caps is very completely equipped. The principal alloys used are:

brass, (70 copper 30 tin); copper-nickel, (80 copper 20 nickel), manganese-bronze, gun-metal and aluminium-brass. The copper is obtained from Australia and Japan, the zinc from Europe, nickel from Australia, the tin comes from the Straits and the aluminium comes from Great Britain. There is an extensive range of furnaces for melting down these alloys, and great care is taken to get them of the proper composition. About £600 worth of plumbago crucibles are used up per month. It would be of great advantage to the factory at the present time, if they could obtain suitable plumbago crucibles made in this country, and it is proposed to make some experiments in this direction. The worn out crucibles are broken up and ground under edge runners, and the graphite contents separated by a lixiviation process, which yields an 80 per cent. graphite suitable for lubrication purposes.

The ingot metal from the foundry is mostly rolled into strips, and there are a number of suitable mills for this purpose. Wide plates are not required in the factory and are not rolled. The strips or ribbons are very carefully rolled to the proper gauge and are almost entirely converted into discs by suitable punching machines. For the heavy cartridge cases, the discs are roughly a quarter of an inch thick, and the earlier drawing operations are done with machines constructed on the Polte system, in which the outer die in an ordinary drawing press is replaced by revolving steel balls through which the punch, operated by a powerful screw, forces the disc. Instead of drawing the metal, it is really spun, and the tremendously heavy pressures which would be necessary in a drawing press are avoided. For subsequent operations, ordinary drawing presses are used. Between each operation, it is necessary to anneal the metal, and the annealing furnaces are kept at a constant temperature which is under control by electric pyrometers. The temperatures used in annealing range from 520° to 675°C., the higher temperatures being used at the earlier stages of the work. For making dies and punches and other tools, there is a specially equipped workshop which contains a large number of fairly good tools.

Under war conditions, the factory now works two shifts of 11 hours each and employs about 5,000 men.

The Cossipore Shell Factory.—In this factory guns up to 4·5 inch bore are made; but the rough forgings of these are sent out from home. The machine tools in the gun section of the factory are capable of turning out guns up to 6 inch bore. The major portion of the factory is devoted to the manufacture of shells and fuse caps and miscellaneous details connected with ordnance work. Comparatively, few really high class modern tools were in use. There were several automatic lathes and a fair number of "Capstan" lathes, the rest of the machines being of an antiquated pattern.

For the shrapnel shells, lead bullets are required, and these are made of a compound of lead and antimony in the proportion of seven to one. The bullets are cast by hand in small metal moulds, the runners sheared off and the balls polished in a tumbler. Each shrapnel case is filled with a given weight of lead bullets, the intervening spaces being filled with resin. The shell bodies are coated with copal varnish and dried in a stove for two hours. Previous to the war, the practice was to dry the varnish for eight hours. Owing to the much greater output since the war, the cost of manufacture has been considerably reduced, and further economies have been effected by a less rigid insistence upon extreme accuracy in unessential parts.

Judging from the published accounts of shell factories, which have recently been erected in England, the equipment at Cossipore must be generally described as out of date and inefficient. This is partly due to the conditions which the factory has to meet. About thirty different types of shell must be turned out, and no care is taken in making requisitions for the same, so that the plant of the factory can be arranged for a long and continuous straight run of work.

This factory also employs about 5,000 men, now that it is working double shifts. The number of Service officers to control so large a body of labour is extremely small, and, all told, there are only now about 50 European trained men in these two factories. All the work turned out must be of a very high

order of accuracy, and it is satisfactory to record that Indian workmen can be comparatively easily trained to attain the necessary standard.

THE BUCKINGHAM AND THE CARNATIC MILLS, MADRAS.

Visited 23rd January 1917.

Of the three cotton mills now working in Madras, two, namely the Buckingham and the Carnatic Mills, are managed by Messrs. Binny & Company, Limited. They are situated to the north of the town, in the suburb of Perambur, and the mill compounds are contiguous. The Buckingham Mill contains 33,512 spindles and 1,048 looms, and the Carnatic Mill contains 32,192 spindles and 926 looms. Though they differ in many details of equipment, the mills are run on the same general principles, and in the social and educational work they are associated.

The Members of the Commission made a detailed inspection of the Buckingham Mills. The principal sources of motive power were two 1,200 h.p., four cylinder triple-expansion engines and one 500 h.p uniflow engine. Electric driving is not in use in these mills; but otherwise in regard to motive power, they represent the very best modern practice. The high price of fuel in Madras (coal costing usually from Rs. 13 to 14 a ton) renders this essential. In the Carnatic Mill, a large Diesel engine has also been installed; but the experience with it, although by no means unsatisfactory, has not warranted further developments in this direction.

At the present time, all the yarn spun in the mills is used in the looms, which are mainly engaged on the production of khaki cloth for the Army. In normal times, the mills are celebrated for the wide range of their productions, which include many classes of fancy goods. Twenty Northcrop automatic looms, recently installed, have given such satisfactory results that Messrs. Binny and Company have put in 300 more of these looms in the new weaving shed of the Bangalore mills. Mention may also be made of the machines for combing out short staples, as these are not commonly found in Indian spinning mills.

The dye house, which is now chiefly devoted to the production of khaki dye, is quite up to date and is under the control of three European chemists. The bleach liquors are produced electrolytically by the Mather and Platt process. The waste liquors from the dye house are subjected to an elaborate system of filtration and purification before they are discharged into the Ottary Nulla, a natural drain between the two mill compounds.

A noteworthy feature in the working of these mills is their order and cleanliness, also the very high state of discipline which is maintained throughout. The mill compound is paved with cobble stones and is extraordinarily clean and free from dust.

To the north of the mills, the company have acquired a large area of land on which they have built a considerable number of excellent bungalows for their European staff. They have also provided a club-house and a large building designed as bachelor quarters for the single men.

The provision for the education of the half-timers employed in the mill and for other operatives is unique in India. The work was started some 10 or 12 years ago and has gradually developed. The school buildings are excellent, and the teaching staff is under the control of two English ladies, one of whom is an M.A. of the London University and the other a kindergarten specialist. Attendance in the schools is voluntary, and there is apparently no necessity for compulsion, as the advantages of education are now greatly appreciated by the mill operatives.

There are elementary technical classes conducted in the evening by some of the mill staff, but as yet this branch of the work is not greatly developed.

The schools receive a grant in aid from Government of Rs. 3,000 a year and are inspected by the officers of the Education Department. It is here unnecessary to repeat the information regarding the results achieved by these schools, which is contained in the evidence tendered to the Commission by

Sir Clement Simpson; but, briefly, it may be stated that, apart from any other considerations, the money spent on this educational work is considered to be a very good investment.

As yet, no provision has been made for housing the workmen; but this is a matter which the Directors have in contemplation.

For the benefit of the work-people, the company have established a gratuity fund, and each operative is credited monthly with 5 per cent. of the wages he has earned. The amount so credited in the half year is doubled if the half year's working of the factory has been satisfactory. At the end of 10 years the operative may withdraw the amount standing to his credit or transfer it to an account in the Work-peoples' Savings Bank, also established by the company, on which interest at the rate of 4 per cent. is paid. After 10 years' service, if the operative continues in the service of the company, he is entitled to an increased gratuity of $7\frac{1}{2}$ per cent., which he may withdraw on similar terms, at the end of a further period of 7 years' service. The rules under which this fund is worked are printed in every pass book in both English and Tamil, and they are eminently fair to the operative, who is not asked to make any contribution himself. Their object is, of course, to secure a steady and continuous attendance, and in this they seem to have succeeded.

For the convenience of the employés, a Savings Bank has also been established, and on the deposits made therein interest is allowed at the rate of 4 per cent. per annum, payable half yearly. Besides those funds for the work-people, there is an officers' provident fund, to which the company make half-yearly donations, the amount depending on the results of the half year's working.

Attached to the mills is a *chattram* which provides a cooking, eating, resting place and shelter for work-people, with separate accommodation for different religious and castes, and a sleeping place for single men coming from up country until they get suitable lodging.

There is in the mill compound a dispensary under the charge of the company's medical officer.

There is also a recreation ground adjoining the schools, to which the work-people are admitted on all days of the week between 6 A.M., and 6 P.M.

The uniformly successful results achieved by both these mills in recent years may be taken as evidence that the very practical measures detailed above for the welfare of the work-people have conduced to smooth working and harmonious relations between the company and their employés.

MESSRS. CHAMBERS AND COMPANY'S TANNERY AT PALLAVARAM.

Visited 25th January 1917.

Pallavaram is about 11 miles south of Madras and is the centre of a number of hide tanneries producing light-tanned leather, for which Madras is well known. Mr. Chambers was working one such tannery at the time when experimental work in the manufacture of chrome leather was started in the Madras School of Arts. The Assistant who was directly in charge of the chrome-tanning experiments was an European, Mr. G. E. Brand, who was then living with Mr. Chambers, and it was in consequence of the information supplied by Mr. Brand that Mr. Chambers started experimenting in chrome tanning on somewhat similar lines, though his earlier efforts met with little success. As the Government chrome-tanning business developed, so did that of Mr. Chambers, but always a few months later. The premature closing of the Government tannery was distinctly prejudicial to the development of the industry; but it is to the credit of Mr. Chambers that he persevered with the work in spite of many difficulties, and there is no doubt that his intimate acquaintance with the hide and skin trade of the Presidency has materially contributed to the successful development of the tannery and leather-working factory inspected by the Commission at Pallavaram.

The tannery is on a considerable scale and employs about 1,100 men, for whose accommodation 300 houses have been erected in the neighbourhood. The tannery buildings have been extended from time to time with the development of the business and are of a semi-permanent character.

Both chrome tanning and bark tanning are carried on. A considerable amount of machinery is employed, and what in India is considered a high-class leather is turned out. Since the outbreak of the war, large army contracts have been obtained. The manufacture of ammunition boots was taken up, but abandoned as not being profitable at the Cawnpore rates.

At the time of the Commission's visit, a good deal of harness work was in hand, but of a quality distinctly inferior to that turned out in the Government Harness Factory at Cawnpore.

A few months ago all the boot-making machinery of the Mysore Chrome Tannery was sold to Messrs. Chambers & Co., and is now working at Pallavaram. For two or three years the Mysore company ran this machinery at a dead loss, entirely owing to labour difficulties, which do not exist to anything like the same extent at Pallavaram. A very large variety of work is turned out in this tannery and leather factory, the best of which is undoubtedly the various lines of boots and shoes, chiefly made for the Calcutta market. The tannery is obviously the creation of a business man picking up manufacturing experience as he goes along.

Mr. Chambers stated that in the initial stages he lost money, but that latterly he had been working at a fair profit. The value of the block may be estimated at about four lakhs of rupees, with probably five lakhs of rupees worth of stock. Sooner or later, the factory will have to be re-constructed, if modern forms of tanning and leather manufacture are to be introduced in the south of India. The Southern Presidency is favourably situated for the development of tanning owing to the existence of a very large class of suitable labour, and in this respect it is much better off than Bengal. If the whole of the hide trade of Bengal were diverted to Madras to be tanned, there would be little difficulty in finding sufficient labour, though there is no doubt that it will take years to train it properly.

THE INDIAN ALUMINIUM COMPANY, MADRAS.

Visited 26th January 1917.

At the time of the Commission's visit, the factory was practically shut down owing to the exhaustion of the supplies of sheet aluminium, which hitherto the company had obtained from the British Aluminium Company in Great Britain. Tentative steps were being taken to develop new lines of manufacture in brass and copper. The factory is very completely equipped with machinery for turning out hollow-ware and both drawing and spinning are very largely employed. A good deal of work is still done by hand by indigenous coppersmiths, but this is mainly for supplying orders which are not big enough to justify the application of machine methods.

At the outbreak of the war, the company held very large stocks of aluminium, and these have been mainly used to supply the requirements of the Indian Army. The chief lines of manufacture are seamless water bottles, nests of cooking pots, eating trays, ration carriers and tumblers. The company is now manufacturing a number of very large stills and condensers for the sandalwood oil factories of the Mysore State. This is a new line of work and, it is hoped, will lead to further developments. In the past, the company has been very successful commercially and has paid large dividends; but the operations are now restricted through inability to obtain supplies of aluminium and by the very high rates prevailing for sheet brass and copper.

The paid-up capital of the company is slightly over five lakhs of rupees, and it has large reserve funds.

Besides this company, there are a very large number of small Indian firms manufacturing aluminium goods in normal times. These are scattered over

the Presidency ; but the bulk of them are in Rajahmundry and neighbouring towns in the Northern Circars.

The demand for aluminium in India is now on a sufficiently large scale to justify the establishment of a factory to extract the metal from the bauxites which have been found in the Central Provinces. From a military point of view, it would be of advantage if India possessed such works. Practically the whole of the Indian Army is equipped with aluminium cooking utensils supplied by this company, and the people of India are using this metal largely in place of brass and copper. From an economic point of view, there is no doubt that its use should be encouraged, as India would then need to import much smaller quantities of brass and copper. From a hygienic point of view, it possesses great advantages over these metals. The liability to corrosion under certain circumstances is not an insuperable difficulty. It has made progress somewhat slowly ; but the people of India are gradually learning for what purposes aluminium may be fitly employed and when it should not be used.

HENKE'S TILE WORKS, FEROKE.

Visited 1st February 1917.

These tile works were started by a German company, and previous to the war the whole of the capital was held in Germany. Recently, they have been sold to a British company.

The principal product of the factory is Mangalore roofing tiles of which the daily output is about 20,000. The clay is obtained from deposits 6 or 7 miles up the Beypore river.

The superintendent in charge of the factory is Mr. Baker, who was formerly commercial agent of the German company in Bangalore. He has no expert knowledge of the business and is entirely in the hands of the trained *mistries*, who have been in the factory for a considerable time.

The plant and equipment are naturally of German origin and are well and conveniently arranged. One improved Hoffman continuous kiln containing 16 chambers was shown to us. It is worked at the rate of two chambers a day, so that the cycle of operations is completed in eight days.

Besides roofing tiles which are of excellent quality, the factory also turns out salt-glazed earthenware pipes; but they are admittedly inferior to those made at Jubbulpore and Ranigunge. Firebricks and very good wire-cut bricks are manufactured, also various patterns of roofing tiles and, at times, considerable quantities of terra cotta.

The manager complained of shortage of labour, but this seems to be mainly due to inadequate arrangements for accommodating the work-people near the site of the works, also partly to the fact that very low wages were paid. The tiles command a market over the whole of the south of India, and many are shipped to Ceylon in coasting boats.

The industry was first started on the west coast by Germans or Swiss attached to the Basel Mission, and it has grown to very large dimensions, giving employment to a very considerable amount of labour.

Factories of a similar type have been started elsewhere in Coimbatore, Madras, and at various places in the Mysore State ; but owing to the unsuitable character of the clays, they are not altogether a success and usually only command local business.

GOVERNMENT FISH-CANNING STATION, BEYPORE.

Visited 1st February 1917.

The Commission were received at the Government Fish-Canning Station by Sir Frederick Nicholson, K.C.I.E., the Honorary Director of Fisheries, whose disinterested labours, since his retirement from the Madras Civil Service, have resulted in the establishment of a properly organised Fisheries Department,

which has already done much useful work and which promises to become of increasing importance in the future.

The Fish-Canning Station was started to test the possibility of developing a trade in tinned fish, and its equipment and methods of working may be taken to represent the very best modern practice. Owing to the ease with which toxins are developed, it is absolutely essential that the processes of sterilization and the methods of packing should be such as to ensure complete freedom from this risk. On a small scale this has probably been achieved, and a visitor to the factory cannot fail to be impressed with the fact that every possible effort has been made to eliminate these dangers, and experience has shown that the products of the factory are in this respect on an equality with imported goods.

The principal fish brought to the cannery are sardines, mackerel and prawns. There is a complete tin-making plant and, to ensure that the tins are free from rust, they are made from day to day as required for the supplies of fish dealt with. Besides canned fish, smoked fish, salt fish and iced fish are put on the market. The business in the latter forms of preserved fish has not yet greatly developed; but it will become exceedingly important, should deep-sea fishing be introduced, as is proposed, later on.

The Commission were also shown models of the fish guano factories, which have been established along the coast, and which have proved so successful that there are now 240 of them in existence.

Vast shoals of sardines occur on the west coast, and formerly these were netted and brought to the shore and spread out on the sands to be dried by the sun. When the fish were large and contained a considerable percentage of oil, the result was not very satisfactory and the so-called fish manure was most easily handled and yielded the best results from comparatively poor fish. In the new process introduced by the Honorary Director of Fisheries, the sardines are put into large open tanks and boiled. The oil separates out, rises to the surface and is drawn off. The fish cake is put into gunny bags, and the remaining oil and water removed by pressure in a hand-worked screw press. In the best type of factory, steam heating is employed and a clear yellow oil containing a large amount of stearine is obtained. Steam heating entails a steam boiler which adds considerably to the initial capital required, and the majority of the installations consist simply of a boiling tank heated by an open fire. This is not under proper control, and the oil obtained is invariably of a very dark colour. From 10 tons of sardines, which can be delivered at the factory for about Rs. 100, roughly 1½ tons of fish oil and 1½ tons of dry fish guano are obtained. The value of the oil and guano in normal times is approximately Rs. 300, and as the working expenses are said to be only Rs. 50, about one-half of the gross sale-proceeds is clear profit.

There can be no doubt that in the improvement of the manufacture of fish guano very valuable work has been done. The fish canning is at present on a small scale and its commercial prospects have not yet been fully determined. A very limited market has so far been tested and even that has not been regularly supplied. The shoals of sardines vary from year to year and sometimes there are none at all. Only those, which can be landed comparatively close to the station, can be dealt with. It is not yet certain that it will be possible to obtain a supply of other edible fish with sufficient regularity to keep the somewhat highly paid staff of the factory regularly employed, and there is as yet no evidence to show that the profits on the business will be sufficient to pay a satisfactory dividend on the capital invested in the factory.

COCOANUT OIL MILL, CALICUT.

Visited 3rd February 1917.

The oil mill visited by the Commission was owned by Mahomedans from Bombay, and is typical of the class of mills working on the west coast for the extraction of cocoanut oil. The installation consisted of 2½ *ghani* mills arranged in two parallel rows, each mill being driven by bevel gearing from a line shaft running under the mills. The source of motive power

was a steam engine driving a main shaft at right angles to the two lines of mill shafting, the power being transferred by bevel gearing. The arrangement is compact and convenient. As cocoanut oil is easily extracted, the iron *ghani* mill is, for a moderate outturn, a fairly satisfactory way of getting at the oil. There were no filter presses, and the factory is run by rule of thumb, a considerable percentage of oil being left in the cake. Under present conditions, however, it is doubtful if it would pay to extract this oil, as cake rich in oil commands good prices.

THE BASEL MISSION WEAVING ESTABLISHMENT, CALICUT.

Visited 3rd February 1917.

Many missionary bodies working in India have found it expedient to establish industrial schools for training the children belonging to the Mission settlements. Most of these schools originated in orphanages and were specifically intended in the beginning to provide some kind of industrial training so as to enable the orphans to earn their own living. The Basel Mission, who work chiefly in the Malabar district of the Madras Presidency, have, however, adopted a much bolder industrial policy and, through their industrial establishments which are run on a purely commercial basis, affords employment to a very large number of people connected with the Mission. Their principal effort has been in the direction of hand-loom weaving; but they have also large tile factories and at least one mechanical workshop. The very large and flourishing tile industry, the chief product of which is the Mangalore roofing tile, was pioneered by men sent out by the Basel Mission.

Many of their early converts were weavers and, as these people were to some extent ostracised by the rest of the population, the Mission took up in a business-like way the question of providing them with work. They introduced the European hand loom and started weaving factories, concentrating their efforts on the production of cotton goods suitable for use amongst Europeans and Anglo-Indians. Meeting a real demand and using commercial methods to develop their business, these hand-loom weaving factories have proved a great success.

The factory at Calicut visited by the Commission is in every respect a contrast to the surroundings in which the ordinary indigenous weaver works. The buildings and accommodation may be described as luxurious, and the looms and equipment represent the highest development of the various branches of hand-loom weaving that have been taken up. Cotton check suitings, duster cloths, towels of every description and table napery are among the more important lines of manufacture. Tea cloths, table cloths and table napkins may be specially mentioned, and the jacquard looms are practically the same as may be seen in the hand-loom weaving establishments in Belfast, where the finest table linen is turned out. The weaving is of good quality, and it is a pity that such good hand work is put into comparatively inferior raw materials. Mercerised cotton is now to some extent employed, but there seems to be no reason whatever why fine linen yarn should not be imported and the very best class of table linen manufactured. Such goods would probably find a very limited market in India; but weavers earning two annas a day in Calicut should easily be able to compete with hand looms worked by men getting 35 shillings a week in Europe.

Besides weaving, a large number of women are employed on drawn-thread work and embroidery, and for this work imported linen is used. It is difficult to understand why the linen cloth itself is not made in the factory.

At the time of our visit, there were 258 hand looms, some of them capable of weaving cloth 9 feet wide. Of these, 204 were actually at work, and nearly all of them on figured work requiring jacquard harness. The manager stated that the total number of persons working in the factory on the day of the visit was 552.

THE NEW MALABAR TIMBER YARD, CALICUT.

Visited 3rd February 1917.

This was started by a man named Brown, who ran it for a number of years and then converted it into a limited liability company with a capital of six lakhs of rupees. The company soon found itself in difficulties and eventually went into liquidation, the business being taken over by the existing company which is apparently working more satisfactorily. The company has a large trade, its chief sources of supply being the forests in Malabar bordering on the Kallai river.

Most of the plant is old, and the works are badly laid out; but during the last three years, under the supervision of a practical timber man, considerable improvements have been effected. The machinery for breaking down logs consists chiefly of band saws, with circular saws for ripping up the smaller scantlings. There are a few wood-working tools and a number of carpenters are employed in making up the finished work. Most of the work now in hand is for the Military Department, and there is a large contract for special packing cases for the Cordite Factory in the Nilgiris.

The manager of the company complains about the short supply and increasing cost of timber, which he attributes to lack of proper transport facilities in the forests. It should be noted that, although there are large areas of Government forests in the district, the supplies of timber are chiefly drawn from privately owned forests.

THE GOVERNMENT SOAP FACTORY, CALICUT.

Visited 3rd February 1917.

This small soap factory has been started by Sir Frederick Nicholson, the Honorary Director of Fisheries, but it can hardly be described as a legitimate outcome of the work of the Fisheries Department. A chemist was engaged to deal with problems connected with fish oil. He happened also to have received some training in the manufacture of soap and, apparently, as there was not enough work to keep him fully employed on fish oil, he was set to work to make experiments in the manufacture of soaps from the vegetable oils available on the west coast. The early experiments promised well, and eventually Government placed the sum of Rs. 75,000 at the disposal of the Honorary Director of Fisheries to establish this soap factory. A five-ton soap kettle has been installed, and there is a fairly up-to-date plant for making both common and toilet soaps. The products of the factory are of good quality and should find a ready sale; but so far, very little has been done to develop this side of the venture, and the stocks of soap in hand are somewhat heavy. It cannot be said that any really useful result has been achieved; but if the factory can be made a commercial success, which is however more than doubtful under normal conditions, it should be the pioneer of many small soap factories. An initial mistake was made in allowing the experiments to be started in the Fisheries Department, and the sooner the factory is transferred to the Department of Industries the better. The establishment of this factory is undoubtedly due to the strong personality of the Honorary Director of Fisheries, who has been allowed to embark on an undertaking in no way connected with the department which he controls.

THE SINGANALLUR JAGGERY FACTORY.

Visited 8th February 1917.

This is a demonstration factory established by the Department of Industries, Madras, with a view to introducing improved methods of cane crushing and jaggery boiling. The history of the experimental work on jaggery manufacture, which began in this factory in 1912, is fully described in bulletins issued by the Department of Industries in Mysore and by the Agricultural Department at Pusa. The present plant, which is the outcome of many experiments, consists of a 12 h. p. oil engine driving a three-roller mill, with rollers 12" in diameter and 18" long. The juice from the mill is boiled down

in four sets of three pans, arranged in tiers, with a special furnace for burning the megasse. The factory had just completed its season's work and had manufactured 6,000 maunds of jaggery (one maund=82⅔ pounds). In an adjoining shed was a very large quantity of megasse, clearly proving that the megasse from the cane-crushing mill, was more than sufficient to manufacture the jaggery. The freshly cut cane is brought in by the neighbouring ryots and the jaggery produced therefrom is returned to them, a charge of Re. 1 per maund being made to cover the cost of running the plant. Some ryots who were present spoke favourably of the work of the factory and admitted that they got at least ten per cent. more jaggery owing to the use of the power mill, and that it also relieved their cattle from the very heavy work of cane crushing. Roughly, the profit on the working of the factory during the season was half the gross receipts and was more than sufficient to cover the interest and depreciation charges The net gain to the ryots using the factory was at least 600 maunds of jaggery worth Rs. 7 a maund or Rs. 4,200. The saving due to the substitution of a mechanically driven plant for cattle power cannot be accurately determined, but is certainly a very large sum. Calculations made in connection with similar plants working in Mysore indicate that roughly the total annual saving due to their employment is about equal to the capital value of the plant installed. At pre-war prices, this amounted to about Rs. 12,000.

THE SANDALWOOD OIL FACTORY, BANGALORE.

Visited 11th February 1917.

All the sandalwood grown in Mysore belongs to the State and, up till the outbreak of war, was disposed of at annual auction sales held in the month of November. The wood is chiefly valued for the oil which can be extracted from it, and the bulk of it found its way into Germany. In November 1914, the auction sales were held as usual; but there were no bidders, and the Director of Industries thereupon suggested to the Mysore Government that the time was opportune for developing the business of extracting oil in the State itself. It was recognised that a good deal of preliminary experimental work was necessary and that facilities for carrying out such existed in the applied chemistry department of the Indian Institute of Science. The experimental work was successfully carried out by Messrs. Sudborough and Watson and, at the prices then prevailing for sandalwood, it was calculated that the cost of manufacturing the oil would be about Rs. 12-8-0 a pound, whilst the prices then current were over Rs. 15 a pound. In October 1915, the Mysore Government sanctioned the erection of a factory, estimated to cost about a lakh of rupees, on the land adjacent to the property of the Indian Institute of Science. Owing to the war, there was a great difficulty in getting plant and machinery, and nearly everything installed in the factory is either second-hand or of local manufacture.

The experimental work had indicated that a process of steam distillation was suitable and that the wood should be prepared in the form of thin flakes or shavings. It was found that suitable machinery, could be obtained from America, but the plant ordered has not yet arrived, and temporarily the methods for preparing the wood are somewhat crude and not altogether satisfactory. Disc planes are used to prepare shavings, and these are mixed with wood powdered in a disintegrator. The mixture of shavings and powdered wood in the ratio of one to three is sufficiently porous to allow the steam access to every particle of wood. The stills are made of copper, are cylindrical in shape and at the bottom are fitted with an open steam coil, whilst at the top, there is a goose neck to carry off the mixture of oil and steam to the condensers. The factory is now equipped with 12 stills, the cylindrical portion of which is 4 feet in diameter and 4 feet high, with one still 4 feet in diameter and 12 feet high and another still 6 feet in diameter and 8 feet high.

Commencing work in May 1916, the output of the oil has gradually risen to over 5,000 pounds a month. Simultaneously, the price of oil has also risen till, at the present time, it is sold naked at the factory for Rs. 30 a pound. The net profits of the factory already amount to three times the original capital outlay. Steam is provided by a Lancashire boiler fired with wood fuel and

also, recently, by a Cornish boiler fitted with a special type of furnace for burning the spent sandalwood.

Previous to the establishment of this factory, Indian sandalwood oil was not acceptable to the London market. Messrs. Sudborough and Watson of the Indian Institute of Science have been retained as consulting chemists, and to each consignment of oil sent to London a certificate of quality issued by them is attached. Every possible care is taken to manufacture the very highest grade of oil, and the success is marked, as the oil now readily commands the highest prices ever obtained for this commodity in London.

A new factory is now under construction in Mysore, which will enable the whole output of the sandalwood in the State to be dealt with, and it is anticipated that in future the Government net revenue from sandalwood, which previous to the war was over 20 lakhs of rupees, will be more than doubled and the site of the industry permanently transferred to the Mysore State.

THE KOLAR GOLD FIELDS.

Visited 12th February 1917.

On these gold fields, five mining companies are still working, two are in suspense and eleven have ceased operations. The Members of the Commission spent a day on the field and were shown some of the more important works belonging to the Mysore and Champion Reef Mines.

They first visited the Edgar shaft of the Mysore Mine and descended to the 32nd level, which is about 2,500 feet vertically below the surface of the ground. Here, some stoping operations were seen in progress, and the excellent natural ventilation, due to the large vertical shaft, practically tested. On the surface, the winding engines were inspected, and it was noted that, though they were originally constructed as two-cylinder, tandem, compound condensing engines, in practice it was found more convenient to work them as single-cylinder non-condensing engines. This is, of course, due to the intermittent character of the load.

The Giffard shaft of the Champion Reef Mine was also visited, and a descent made to a level 3,750 feet below the surface of the ground. This shaft is about 4,000 feet deep and has reached the economic limit for a single lift, lower levels being worked by subsidiary shafts by means of winding engines electrically driven.

At one or other of the two mines, all the processes through which the ore passes, from the time it is removed from the stopes till the sponge gold is melted down into ingots, were shown. These mines have been continuously worked since the early days and have yielded gold to the value of £47,000,000. At the beginning, the methods of extraction were crude and inefficient, but as the mines developed, it became possible to instal the very highest class of mining machinery and the most efficient type of recovery plant, so that it is probable that at the present time there are no better or more substantially equipped mines in the world.

A noteworthy feature in the working of these mines is the extensive use that is made of electric energy, supplied from the Sivasamudram hydro-electric station of the Mysore Government. Beginning with 4,000 h.p. some few years ago, the supply of electric energy has been increased till now it amounts to 12,000 k. w., and for each k. w., year, the mining companies pay the Durbar £12.

The natural flow in the Cauvery river during the hot months of the year is supplemented by water stored behind the large dam erected across the river at Kannambadi and, since these hydraulic works have come into operation, all danger of a short supply of electric energy has been removed. These hydro-electric works have greatly reduced the cost of power on the mines and have, at the same time, proved an extremely profitable investment to the Mysore Government. To generate the same amount of power by burning coal under steam boilers, would require about 140,000 tons of coal annually. This saving of fuel is a matter of considerable importance under present war conditions.

The Sivasamudram hydro-electric station is 90 miles from Kolar, and the voltage employed is 70,000 with a drop of 5,000 volts on the transmission line.

The Mysore transformer house and the Kolar Mines generating station were both inspected. The latter was originally started to supplement the electric supply from Sivasamudram; but it is now chiefly used as a stand-by in case of any interruption on the main transmission line. The power is handed over to the mines at a pressure of 2,300 volts, and by means of rotary converters and transformers, it is transformed to suit the requirements of the various classes of machinery in operation. A notable feature of the power station is the very large battery of accumulators used to take peak loads and to maintain during short periods of interruption the supply of current absolutely necessary to prevent a breakdown.

The deepest works on this field now exceed 5,000 feet and, although the rock temperatures at the bottom levels are extremely high, the natural ventilation is sufficient, the flow of air down the big main shafts being as much as 80,000 cubic feet a minute.

The mines are singularly free from dust, and miner's phthisis is unknown. Air blasts are, however, of frequent occurrence and, quite recently, it has been necessary to close down a considerable section of the Champion Reef Mine. It is hoped that the internal stress to which the rock is subjected will be gradually relieved and that in course of time it will disappear.

The general appearance of the Kolar Gold Fields is that of a prosperous industrial community, and there are practically no traces of the temporary equipment usually found in mining camps.

THE STEAM JAGGERY-BOILING PLANT, AGARAM.

Visited 13th February 1917.

For the last four years, the Department of Industries in Mysore has been engaged in experimental work to improve the methods of manufacturing jaggery from sugarcane. A number of plants, similar to that visited at Singanallur in the Coimbatore district of the Madras Presidency, have been installed and are working satisfactorily; but the methods employed in these small factories are not suitable for any large scale operation. The economic limit for such factories is reached when the output of jaggery amounts to about three tons per day of 24 hours, and it was thought that for larger factories the work would be better done by employing steam heating. This would lead to a greater economy in fuel and to a saving of considerable amount of labour, and would produce a much better quality of jaggery.

The Agaram plant was established as an experiment to obtain information on these points. As a commercial venture, the factory is not a success having been planned on too small a scale fully to develop the advantages of the system of working. Regarded as an experiment, it has yielded much valuable information, and has proved beyond doubt that steam heating should be employed when the quantities of cane to be dealt with are large. Briefly, the plant consists of a steam-boiler fitted with a megasse burning furnace. The juice from the cane mill, which is worked by an oil engine, is pumped into rectangular tanks fitted with steam coils, whereby the juice can be heated. In these tanks, lime is added and the scum rising to the surface as the heating proceeds removed. The juice is not allowed to boil but, as soon as the scum ceases to rise to the surface, it is allowed to flow by gravitation into large steam-heated evaporators, where concentration rapidly takes place. When the temperature of the juice begins to rise above 100° C., the syrup is transferred to a Wetzel pan. This consists of a rectangular trough with a semi-circular bottom, in which revolves a spiral coil of copper steam pipe. The steam pipe is mounted on trunnion bearings fitted with glands. The coil is partially immersed in the syrup and, as it revolves, it carries into the atmosphere a thin film of syrup which rapidly evaporates. By this means the syrup can be deprived of all water, the temperature rising during the process till, at the end of the operation, it is about 123°C.

When ebullition practically ceases, the now very thick syrup is discharged through a valve in the bottom, and either worked up into balls by hand or poured on to mould-boards where it quickly sets. The jaggery thus produced is very clean and free from all caramalization, so that the characteristic smell of jaggery boiling is entirely absent in the factory. The experiments at Agaram clearly show that steam heating possesses many advantages but that, on account of the initial cost of the plant and the large amount of apparatus employed, it is not capable of being worked economically on a small scale. A minimum outturn of about five tons of jaggery per day seems to be the economic limit. This means that steam heating should only be employed when at least 4,000 tons of cane are available each season. Where much larger areas than this are available, still more advanced methods of evaporating the juice can be employed, such as triple effect evaporators and possibly vacuum pans fitted with stirrers.

GREAT INDIAN PENINSULA RAILWAY CARRIAGE AND WAGON WORKSHOPS, MATUNGA.

Visited 17th November 1917.

The scale on which these workshops have been built is perhaps best indicated by the fact that they give employment, in normal times, to about 5,000 men, and are the principal construction and repair shops of a railway equipped with about 19,000 carriages and wagons. Besides these workshops, there are others on a smaller scale at Jhansi, Bhusawal and Poona. The Matunga workshops have been built within the last ten years, and the Carriage and Wagon Superintendent stated that they had cost approximately a crore of rupees. In their design and arrangement are embodied all the best features of modern practice, with a view to securing the minimum possible handling of material and to providing for the convenience of the work-people in a hot climate.

The sheds cover a very large area, are well built, lofty and excellently ventilated. A central power station supplies electricity for driving all machinery. It contains three Belliss and Morcombe engines, direct-coupled to dynamos of 350, 250 and 80 k. w. capacity respectively. The voltage employed is 250 continuous current. Steam is supplied by a battery of Babcock and Wilcox boilers, one of which is specially fitted for burning waste wood. The others are supplied with mechanical stokers.

Starting from the timber yard, the logs pass into the shed containing the saw mills and all the other wood-working machinery. The wrought timber is then carried forward to the erecting shop, and finally the completed carriages and wagons are moved into the paint shop, which occupies a position least effected by the dirt and dust from the other sheds. Parallel with this line of shops, are others dealing with the metal work. These consist of a foundry, with a number of small cupolas and a large moulding floor, a smith's shop, with 150 forges provided with down-draught hoods and underground flumes connected to the chimney, and a machine shop which is not yet completely equipped.

So far as can be judged from a somewhat hasty inspection, these workshops appear to be admirably adapted for dealing with a very large amount of construction work. The conditions at the present time are abnormal on account of the war, and about 90 per cent. of the work is said to be for the Indian Munitions Board. Since the war broke out 80 long military cars have been completely built in the shops and, at the time of our visit, 100 wooden pontoons were in course of construction. Oregon pine and deodar are the principal woods used in such work.

Interest chiefly centres around the expedients employed to overcome the difficulties presented by the shortage of material usually imported from England. A good deal of ingenuity was in evidence in respect to utilising old axles, and tyres and springs are now constructed from plates rolled from old tyres, a special mill for the rolling of such plates having been constructed and set up in the locomotive shops at Parel. The extreme shortage of white lead as a body

for paints has been overcome by the use of oxide of iron of local origin, and country-pressed and boiled linseed oil has entirely superseded the imported material.

Quite a large amount of miscellaneous work is necessarily carried on to supply the very varied details which go to make up a finished railway carriage. On the Great Indian Peninsula Railway, the carriages are lit with electricity on the Mather and Platt system, and the repair work connected with dynamos, batteries, lamps and fans was in evidence. Sample collections of metal fittings of most excellent quality were shown to us, conclusively proving that all such miscellaneous metal work can be made in this country quite as well as elsewhere.

Our attention was drawn to a number of constructional details in the storage batteries sent out from England, which experience has shown are unsuited to Indian conditions. Though the consequent inconvenience has been brought to the notice of the manufacturers and licensees of the controlling patents, it appears they are unwilling to alter their standard patterns. A local branch factory would better appreciate the trouble and would doubtless be more amenable to suggestions.

Unlike the majority of the Indian railway workshops, which have grown up with the extensions of the lines and the increased demands for equipment, these workshops have been planned as a whole and throughout exemplify the advantages to be attained when such a course is possible.

Considering the congested state of Bombay it is a matter of regret that when it became necessary to construct these workshops some other site was not selected on the railway, where the conditions for housing labour would have been more favourable.

SCHOOL OF ART, BOMBAY.

Visited 19th November 1917.

This institution which, according to the Principal, was founded in 1859, now consists of three main sections, one devoted to drawing and the fine arts, one to the teaching of elementary craftsmanship, and the third to research work and advanced craftsmanship.

The Commission confined its inspection to the latter two sections, and visited only what are known as the Reay Art Workshops and the pottery section. Owing to the Depavali holidays, no students or apprentices were at work. The crafts taught in the School include house painting and decorative work, metal work, chiefly in brass and copper, but also in silver, leading up to ornamental repoussé work, carpet weaving, carpentry, wood carving and light smith's work; the latter being mainly devoted to the manufacture of wrought iron grille work. This class is said to be extremely popular. The equipment of the workshop was somewhat incongruous including as it did several heavy machine tools which must have cost a good deal of money and are utterly out of place. Intermediate between the fine arts and the industrial sections are classes for stone carving and architectural drawing. The latter apparently supply a real need and are largely attended. We also saw some boys in the School compound who were going through a course of instruction in surveying. The reason for attaching such a class to the School is not self-evident.

Somewhat similar industrial classes to those just described were found by the Commission at Lucknow and in the Madras School of Arts. They are, also to be found in a good many industrial schools; but it is doubtful if they are of much utility. Only to a very limited degree do they serve to maintain high standards of indigenous craftsmanship, as it is undoubtedly a fact that much better work is done by independent craftsmen. The real defect in these classes is that they lead to nothing. The pupils pass out of them usually before they have completed their course of training and obtain employment in small second-class workshops. Those of more than average ability get few opportunities to display their skill. It might be thought that these classes meet a genuine demand for instruction; but in reality, it is artificial, having

been created by the provision of scholarships, and if these scholarships were abolished, the students would probably also disappear. It is the scholarship that attracts the students, and generally they are drawn from classes not directly connected with the crafts they endeavour to learn.

The influence which these classes have over the indigenous crafts of the country is therefore of a negligible character, and it would seem sound policy either to discontinue the classes or to develop them to their logical conclusion, which may be taken to be that the training given in them should be followed up in the subsequent careers of the students, and that they should be provided with opportunities for displaying to the utmost degree possible their skill in craftsmanship. That is to say, the classes should be directly connected with art workshops, in the management of which commercial considerations should be accorded a proper degree of attention.

There is little doubt but that in normal times Indian handicraft is widely appreciated; but modern work suffers from the fact that it is the product of men who are completely out of touch with the environment in which their work will be displayed, and it is in consequence full of defects in design and overloaded with ornament.

The pottery department combine experiments in the manufacture of art pottery with investigations into the suitability of Indian clays for various classes of ceramic work. The specimens of art work shown to us were of a very promising character; but apparently nothing is done to extend the scale of operations on a commercial basis. A very large number of Indian clays have been examined by Mr. Fern, the superintendent of this section, and the information obtained is communicated to the owners of the clay deposits and is recorded in the office. The equipment of the experimental section appears to be adequate, and the specimens of work turned out serve to demonstrate the value of the material employed. A number of students from various parts of India are working in this section; but it is certain that the training they receive is not such as would fit them for practical work afterwards. There are two small kilns, and all the operations are conducted on a very small scale, without any regard whatever to the cost. Some further action seems necessary, so as to make practical use of the work which has been done in the past and which may be done in the future. This might take the form of a demonstration pottery in or near Bombay, where the results obtained in the laboratory will be subjected to practical trials, and where the various processes of manufacture will be carried on with a view to training people engaged in or desirous of taking up the manufacture of various classes of pottery. This logical development of the work of the research laboratory would provide data regarding commercial prospects which are now lacking, the absence of which has hitherto prevented any practical results accruing from the investigations which have been made.

THE VICTORIA JUBILEE TECHNICAL INSTITUTE, BOMBAY.

Visited 20th November 1917.

This institution was founded in 1887 to commemorate the Jubilee of Queen Victoria. The funds to start with were provided by the amalgamation of the Ripon Memorial Fund with the Municipal and Royal Jubilee Funds, to which Sir Dinshaw Manackjee Petit added an endowment fund of three lakhs of rupees. The Institute is controlled by a Board of Trustees, the members of which are nominated by Government, the Municipal Corporation, the Committee of the Ripon Memorial Fund, the Mill Owner's Association and the Committee of the Sir Jamsetjee Memorial Fund. Throughout its history, Government have liberally supported the Institute and at the present time give an annual grant of a lakh of rupees; the Bombay Municipality contributes Rs. 20,000 a year and the Bombay Mill Owners' Association Rs. 2,000. The average annual expenditure amounts to about Rs. 1,55,000, the additional income to meet which, beyond that already mentioned, is furnished by interest on invested funds, fees charged to students and miscellaneous

receipts, chiefly rent of buildings and realisations on account of work done in the workshops. The number of students this year is 340, and the fees paid by them amount to Rs. 17,500.

Five courses of instruction are provided :—

(1) Mechanical Engineering ;
(2) Textile Manufacture ;
(3) Electrical Engineering ;
(4) Technical Chemistry ; and
(5) Plumbing and Sanitary Engineering.

Except for textile manufacture, the courses of instruction are designed to cover a period of four years. The first three years are spent in the Institute, and the first half of the fourth year on practical work outside, the students returning for the last half of the fourth year, at the end of which the final examinations are held.

Students are only admitted to the Institute after passing an entrance examination : but applicants for admission who have passed the P. E. examination of the University are exempted. In June last, students were admitted as follows :—

Mechanical Engineering	36
Electrical Engineering	36
Textile Manufacture	24
Technical Chemistry	9
Plumbing and Sanitary Engineering	17

Apparently, a very large number of the students fall out by the way, as on the 31st of March of this year, there were 122 first year, 95 second year, 69 third year and 53 fourth year students, whilst the corresponding admissions were 122, 114 and for the fourth year 117 : the figures for the year 1914-15 which relate to the present third year students, are not available in the report. That is to say, of 117 students admitted in 1913-14 only 53 reached their fourth year.

At the end of the course, the Institute grants diplomas, first, second and third class. Up to date, 1,181 diplomas have been granted, of which 556 were first class, 526 second class and 99 third class. The detailed distribution of these diplomas is shown in the following table :—

Year.	Mechanical Engineering.	Textile Manufacture.	Electrical Engineering.	Technical Chemistry.
1st class	339	134	79	4
2nd class	303	85	131	7
3rd class	48	14	35	2
Total	690	233	245	13

Detailed enquiries have been made regarding the future careers of students, the results of which are published in the twenty-five years' record of Technical Education in Bombay, copies of which were supplied to the Members inspecting the Institute ; and, generally speaking, it may be said that the past students have done well.

A large number of the students in the Mechanical Engineering class appear for examinations under the Bombay Boiler Act, which prescribes that candidates for certificates of the first or the second class must have served as an apprentice to an engineer for not less than three years or have completed a full three years' course in certain specified institutions, of which the Victoria Jubilee Technical Institute in Bombay is one, and that after such a course they

must have served as an apprentice to an engineer or be employed as a mechanic in a factory or workshop for a period of not less than one year.

A number of the students also appear for the technological examinations of the City and Guilds of the London Institute, and it may be interesting to tabulate the results obtained in 1916 :—

	Entered.	Passed.
Cotton spinning	7	7
„ weaving	30	15
Silk throwing and spinning	2	2
Jute spinning	1	1
Electrical engineering	35	11
Motor car engineering	5	4
Telegraphy	22	12
Telephony	5	3
Electric wireman's work	3	3
Plumber's work	5	3
Silk dyeing	1	1

These results are satisfactory ; but it should be noted that the failures in Electrical Engineering were 69 per cent and that no students at all appeared for Mechanical Engineering.

The Commission inspected the laboratories, workshops and class rooms; but it is unnecessary to describe these in detail, as it has been recognised that they are inadequate to meet the needs of the students at the present time, and steps have been taken to transfer the Institute from its present unsatisfactory position to a new site at Matunga, where an area of 16¼ acres have been acquired from the City Improvement Trust. The foundation stone of the new buildings was laid by His Excellency the Governor of Bombay on the 27th of January this year, and the plans of the new buildings which are estimated to cost 12½ lakhs of rupees were shown to the Commission.

Where every effort is being made to provide a thoroughly efficient and up to date course of technical education for students in Bombay, no useful purpose will be served by criticism except on broad lines.

The Mechanical Engineering class owes its popularity to the privileges conferred on it by the Bombay Boilers Act. The instruction is suited to the requirements of operating rather than constructive engineering, and is less in touch with the engineer than the manufacturer. Owing to their non-insistence on adequate workshop experience before granting diplomas, the authorities are scattering all over India certificated but unpractical men, whose livelihood depends largely upon the provisions of a legislative enactment, which ought never to have been made and which is not in force in several provinces.

The Chemistry Department suggests, in a somewhat exaggerated degree, the defect probably to be found throughout the Institute, namely, that with the means at its disposal it is trying to do a little too much. The staff of the Technical Chemistry Department consists of the head of the department and two assistants, and these gentlemen have to provide for specialised instruction in the following branches :—

(1) Oil extraction and purification ;
(2) Manufacture of soap and candles ;
(3) Manufacture of paints and varnishes ;
(4) Analysis of foods and drugs ; and
(5) Textile and tinctorial chemistry.

They have also to give elementary courses of instruction to the students belonging to the other departments. The admissions to the Chemical Department are 7 per annum ; but apparently only one and in the last year, 1916-17, two have obtained diplomas or certificates. Obviously, some effort should be made either to reduce the number of courses or to strengthen the staff and improve the equipment. The heavy failures already alluded to in the City and Guilds London Technological Examinations in Electrical Engi-

neering also point to the same superficial nature of the instruction given. This also may possibly be the reason why the Mechanical Engineering examinations are altogether avoided.

BOMBAY MEDICAL STORES DEPÔT.

Visited 21st November 1917.

The Bombay Medical Stores Depôt is maintained primarily to meet the medical and surgical requirements of military hospitals. It also supplies the civil hospitals and grant-in-aid dispensaries of the Bombay Presidency, whilst the medical institutions supported by Municipalities and Native States are permitted to indent upon it. The depôt is partly a store in which are maintained stocks of European and locally manufactured drugs and chemicals, surgical instruments and surgical appliances, and articles such as dressings and ligatures which are necessary for the treatment of the sick or injured. It also contains a laboratory in which medical preparations and dressings are manufactured and a surgical instrument factory which has reached a very high degree of efficiency, and in which the manufacture of artifical limbs and orthopædic boots has recently been developed.

In the laboratory much miscellaneous work is undertaken. One section is equipped with percolators and macerators for the preparation of tinctures; in a second, high-pressure steam is generated and used for the sterilisation of dressings, which are compressed into portable packages by special machinery; in a third, there is a hydraulic press employed in extracting castor oil without the aid of heat; whilst in a fourth section, there are five stills for spirituous preparations and two open steam-heated pans for the manufacture of ointments. A special machine is employed for spreading resin plaster which is dried in a large and somewhat dirty steam-heated room. This may be taken as the equipment usually found in a Medical Store Depôt; but in Bombay there is also a surgical instrument department which is exceptional.

It appears that some 35 years ago, a surgical instrument maker, Mr. Edmond Eyres, was brought out to Bombay and established in the Medical Stores Depôt to repair instruments. After some time Mr. Eyres, from being a paid servant of Government, became a contractor who was allowed to work in the Medical Stores Depôt. A small factory was started, the building and some of the plant being supplied by Government. Gradually, the factory developed till, at the present time, it occupies a long three-storeyed building in which between 200 and 300 skilled artisans are at work. The Medical Storekeeper in his evidence stated that nothing is made in this factory which does not equal the highest grade production of Europe. An inspection of the factory and its products certainly supports this statement.

The establishment of a private manufacturing concern on the premises of a Government Depôt and the very unbusinesslike arrangements in regard to prices to be charged for goods supplied are unquestionably open to criticism; but the result which is mainly due to the personality of Mr. Eyres, is extremely satisfactory. Mr. Eyres has demonstrated what can be done in India when Indian workmen are properly trained and efficiently supervised. The work turned out in this factory possesses a much higher order of finish than one is accustomed to associate with the hand-made productions of the Indian artisan.

THE TATA HYDRO-ELECTRIC WORKS, LONAVLA.

Visited 24th November 1917.

On the edge of the Western Ghats, in the neighbourhood of Bombay, the rainfall is extremely heavy, averaging probably 200 inches or more during the prevalence of the south-west monsoon and rising, on the tops of some of the hills, to over 500 inches. The configuration of the country lends itself readily to the construction of large storage reservoirs by the erection of masonry dams

across the valleys formed by the spurs running from the edge of the plateau almost due east. In connection with this hydraulic scheme, three lakes have been formed, the largest of which is the Shirawta lake which, when full, will have an area of over 5 square miles with a catchment area of about 11 square miles. The ratio of catchment area to storage capacity is extremely small; but the rainfall, as already noted, is very heavy, and the run-off which is stored amounts to the very high figure of 80 per cent. The dam at Shirawta is not yet completed, and some 40 feet has still to be built. The lake as at present, therefore, only contains a small fraction of the water which it will ultimately hold.

Immediately to the south-west of this lake, and separated from it by only a high spur, is the Walwhan lake, the dam of which is completed and raises the water to about the same level as the bed of the Shirawta lake. Between the two, a tunnel, over 5,000 feet in length, has been made with a cross section of 11 feet by 8½ and to the slope of one in a thousand. At the upper end of the tunnel in the Shirawta lake, sluices are under construction to regulate the discharge from the upper lake into the lower, and it is calculated that it will be possible to pass down approximately 600 cusecs which, running continuously day and night, will be more than sufficient to counterbalance the water drawn off from the duct which leads to the pipe line and thence to the power house at Khapoli.

A third lake, known as the Lonavla lake, lies to the south of the town of that name and has been formed by the construction of two small masonry dams. This latter lake is shallow and has a comparatively small storage capacity, and in the working plan it is emptied soon after the cessation of the monsoon so as to minimise as much as possible the losses by evaporation. It is connected with the main duct from the Walwhan lake by a short channel, provided with sluices for regulating the discharge. The main duct is five miles in length and on a gradient of one in thousand, so that the loss of head in the duct is about 25 feet.

On the edge of the Ghat a small forebay, into which the duct discharges, has been constructed and, as in some parts the foundations were unsatisfactory, it has been lined throughout with concrete covered with a bituminous composition so as to make it water-tight. From the forebay, a single pipe, starting with a diameter of 82 inches and gradually tapering down to 72 inches, has been laid. At a point where the head on this pipe is approximately 500 feet, it is bent round into a goose neck from which five 42-inch pipes take off to carry the water to the power house. The diameter of the pipes is reduced at intervals till at the bottom of the incline it is 38 inches. Each pipe is directly connected to a horizontal Pelton water wheel, capable of generating a maximum of 13,750 h. p. The total length of the pipe line is 13,000 feet and the fall 1,740 feet. The gradient varies a good deal with the configuration of the land, and over considerable lengths the slope is one to one. The pipe line is laid in sections, each section being of a uniform slope and, at each change of gradient, heavy masses of masonry anchor the pipes firmly to the ground. The pipe line was designed from the outset for two delivery pipes from the forebay, but only one has been laid. It intended that a second pipe should be installed as soon as the development of the scheme permits.

The power house at Khapoli at the foot of the Ghat contains five units, each consisting of a Pelton water wheel direct coupled to an alternator capable of supplying a maximum of 10,000 k. w. at a pressure of 5,000 volts. At present only four sets are running and the fifth is held in reserve. With a fall of 1,740 feet, each cusec passing down the pipes should be capable of furnishing about 150 h. p. to the transmission line. Between the alternators and the transmission line are step up transformers raising the pressure to 100,000 volts. The Pelton water wheels were made by Escher Wyss of Zurich, and four of the alternators came from Germany, having been manufactured by Messrs. Siemens, Schukert, to the order of Messrs. Siemens Brothers. The fifth machine was not delivered on account of the war, and for it a substitute was provided by the General Electric Company of New York. The German machines gave a great deal of trouble when first started, owing to defective workmanship, and very serious alterations had to be made to get them

to work satisfactorily. The very successful way in which these difficulties were overcome reflects great credit on the technical staff of the company.

The power is carried to Bombay by two transmission lines on one set of towers, and for each transmission line, as the current is three phase, three wires are necessary. The transmission line is about 42 miles long and runs roughly north-west from the power house till it reaches the Thana creek which is crossed at a high level; thence it runs nearly south-west to the receiving station, where it is transformed down to 6,600 volts and again transformed down at the mills to 2,200 volts, at which pressure the motors work. The power is supplied at a cost of 0·55 annas per unit, when the electric equipment is provided by the company, and at 0·5 annas per unit, when the motors are the property of the consumer. At the present time, approximately 40,000 h. p. is usep in Bombay for a period of 12 hours a day. The load rises early in the morning to its maximum and remains steady till the dinner hour, when it is almost entirely cut off, rising again immediately after the dinner hour is over. Special care has therefore to be taken to regulate the flow of water in the duct. The water takes about an hour to pass from the sluices of the Walwhan dam to the forebay, and regulation must therefore anticipate events by that period to prevent the waste of water over the spillway near the forebay.

The development of the use of electric power in Bombay is naturally greatly retarded by the restriction on imports of electrical machinery which the war has necessitated. Nevertheless, the present supply of power would require for its production at least 150,000 tons of coal per annum, and to that extent the operation of this hydro-electric scheme has relieved the demand upon the coal resources of the country. When the ultimate development expected is reached, the supply of power will be approximately equal to that which can be obtained from the combustion of 400,000 tons of coal per annum.

The technical details of the scheme have from time to time been subjected to much criticism ; but the fact that the installation is now successfully working and yielding a very considerable revenue to its promoters is a practical answer to the critics.

The Walwhan dam shows considerable seepage. Measures are being taken as rapidly as possible, by grouting with cement to diminish the porosity of the masonry.

The whole scheme is an extraordinarily bold one and it is notably so in respect to three main points :—

(1) the extremely small catchment area from which this water supply is derived ;

(2) the main generators work under a head of over 1,700 feet ; and

(3) each individual generating unit is one of very large size.

The success of this installation is a matter of very great importance, as it supplies a much needed example of what can be done in India by Indian promoters with Indian capital. Already, a second and larger scheme has been undertaken, and there is but little doubt that ultimately Bombay will become a completely electrically operated city much to the advantage of its inhabitants.

It has required no small amount of skill and courage to utilise the somewhat extraordinary conditions which exist in the Western Ghats near Bombay. These conditions may rightly be described as favourable ; but this factor was by no means self-evident at the inception of the enterprise.

THE ROYAL INDIAN MARINE DOCKYARD, BOMBAY.

Visited 27th November 1917.

This dockyard dates back to the days when shipbuilding flourished in Bombay and ships of the line were constructed by the Wadias of Indian teak. There are a number of covered slipways ; but these are now only used for small

craft, and up till the outbreak of war recent tendencies did not favour the development of construction work. Even now, very little has been done, apparently owing to the fact that the resources of the dockyard have been fully occupied with the maintenance and repair work essential for the vastly increased naval forces now operating in the East.

The dockyard consists essentially of slipways, store-sheds, dry docks, a large basin and an extensive range of machine shops. To an increasing extent Indian raw material is being used, of which notable instances are the substitution of *chir* pine from the Himalayas for Japanese yellow pine and Oregon pine, and the increasing use of jute fabrics in place of those made from flax. Locally made ropes are largely used, and Indian structural steel to the extent that it is available after the overseas demands of the military authorities have been met. Generally, the Indian raw material is quite satisfactory, but the use of jute in place of flax is a temporary expedient in the nature of a makeshift.

The shops are naturally working at a high pressure, and some 4,500 men are employed. Much of the equipment is antiquated, and the lay-out is cramped and inconvenient, but it must be remembered that the bulk of the work is repair work and that many of the apparently obsolete tools still in use are just as well adapted for such work as more modern machines, chiefly designed with the view to a large outturn.

There is a central power station in which were two Diesel engines direct coupled to dynamos. The engines are of British origin and were made by Messrs. Mirlees, Bickerton and Day.

The officers in charge complain of shortage of skilled labour and the reluctance on the part of the rising generation to enter the dockyard at the bottom. They strongly advocate the introduction of a system of apprenticeship for 5, 6 or 7 years, with legal means of enforcing the conditions stipulated in the indentures. They are of opinion that the ordinary type English indentures modified to suit local conditions might well be introduced. The boys taken into the shops now stay for a year or two and, before their training is half finished, leave to take up a job elsewhere on a few annas more a day than they get in the dockyard. They are only half trained, and half trained they remain for the rest of their lives.

This dockyard does an immense amount of miscellaneous work, and seems admirably adapted for training all classes of artisans connected with mechanical engineering. The very imperfections of the equipment and the absence of repetition work give much greater scope for training and the development of those faculties, in the exercise of which the old English millwright was unrivalled.

SWADESHI STORES, BOMBAY.

Visited 28th November 1917.

The Swadeshi Stores were started in 1906 with an authorised capital of 2½ lakhs rupees. The paid up capital is now Rs. 2,04,390.

Sales were Rs. 4,41,000 in 1907-08, but showed little expansion till the year of the outbreak of war. They have stood as under since the war:—

	Rs.
1914-15	5,74,000
1915-16	8,38,000
1916-17	13,13,000

The Company paid usually 5 per cent. until 1913-14, since then the dividends have been:—

1914-15	7½ per cent.
1915-16	10 „
1916-17	15 „

So far as we could see nothing that was not manufactured wholly or partially in India was on sale. They have 3 branches in Bombay; 2 in Poona,

where one of their Directors, Mr. Tilak, lives; and they are opening one in Cochin. They are hesitating to open a branch in Calcutta, for fear of locking up a lot of goods which will be less readily saleable after the end of the war. Their main shop and branches carry Rs. 4 lakhs of stocks, and they have a sufficient working capital to render it unnecessary to obtain accommodation from a bank.

They have a bespoke tailoring department, which employs 16 power-driven sewing machines.

The manager, who seems a well-informed man, was originally a Bombay piece-goods shopkeeper. The whole store presents the animated appearance of a well-managed departmental store. The great importance of sound business management was obvious.

The Commercial Museum, Calcutta, has been of great assistance to the Stores by showing them the kind of article they can purchase, and putting them in touch with small producers. They also buy from the Cawnpore Village Industries Stores. Their manager or employés tour different parts of India and look for the class of articles for which they anticipate a sale. Where possible, they give regular weekly orders to producers direct, delivery against cash; when dealing with smaller men, such as cutlery workers, they allow cash against partially completed orders: in the case of hand-made piece-goods they obtain the goods through a leading local weaver of the *shetia* type, who undertakes collection. In no cases do they give advances. They take expensive artware, like carved ivory, on consignment-sale terms. They occasionally send out a man to buy valuable hand-made piece-goods from Madura, Benares, etc. They deal direct with domestic workers in Bombay, *e. g.*, workers of leather goods, such as bags. They do not buy from any co-operative industrial societies.

We noticed quilts from Broach, printed goods from Farrukkabad, wooden sandals from Savantvadi, leather sandals from Palamcottah, cutlery from Muzaffarpur, sola topis from Calcutta and Madras.

They informed us that their stores are frequently visited by Japanese who take notes and buy samples. Recently the Consul in Bahrein drew their attention to the sale of purses there as of Japanese make, which they found were really made in India.

There is obviously a fine scope for stores of this kind on a varying scale in the larger towns, which will benefit the artisans; but the present turnover cannot be expected to continue after the war, unless certain classes of goods are improved and prices lowered. The efforts of provincial Departments of Industries to effect improvements of this kind will receive considerable help from institutions like the Swadeshi Stores as buyers and testers of the market; while the stores in their turn may derive assistance from Government organisations for exhibiting samples and collecting cottage-made goods.

SYDENHAM COLLEGE OF COMMERCE, BOMBAY.

Visited 28th November 1917.

The College was opened in October 1913. It is affiliated to the Bombay University. It possesses a building fund of Rs. 2 lakhs, raised by public subscription, and has an income arising from fees, endowments, and grants from public bodies of Rs. 52,000. It also received last year Rs. 15,000 from the Government of India (Delhi Durbar Education Grant) and Rs. 2,000 from the Local Government. It is at present located in temporary quarters, the site, we were informed by the Principal, not yet having been finally determined, and the Local Government also not yet being prepared to contribute the balance required, which will probably amount to another Rs. 2 lakhs.

There are 2 terms in the year and the fee is Rs. 60 for each. There is a hostel at some distance from the present site, residence at which is not obligatory. Students from parts of India outside the Bombay Presidency show signs of increasing.

The main feature of the College is its course in accountancy which, after a subsequent two years apprenticeship, qualifies for an unrestricted certificate as accountant. There are certain matters relating to the recognition by other Local Governments of certificates of accountancy granted on the Sydenham College course which are under discussion between the Government of India and other Local Governments: and it is probable that courses in accountancy will be provided in other parts of India. Further details regarding the curriculum may be found in the literature supplied by Mr. Anstey, the Principal.

He is assisted by an Advisory Board which, either directly or with the help of sub-committees, deals with the administration of the funds, curricula, fees, examinations, etc. The system of teaching is by lectures, the lecture classes being subsequently split into tutorial classes of 30 to 35, which are of course too large, but doubtless the best that can be arranged for at present.

The Principal takes a share in the teaching. The professors seemed at least up to the average type of their class and perhaps in some cases a little beyond it. One of them is Mr. Davar, who also runs a private Commercial College of, presumably, a somewhat less ambitious type.

The first two final examinations have been held this year and the year before, and though a good deal of preliminary selection among would-be entrants is exercised, only 25 per cent. of these pass the final examination with success.

The students who failed at the last examination have appealed to the Syndicate, in particular alleging that the paper on political theory was of too advanced a nature.

The class who passed last year seem to have obtained employment with good firms in a number of cases. This is doubtless partly due to the interest of some of the employers, *e.g.*, Messrs. Tata, Messrs. Ferguson, etc., in the success of the college, and partly also no doubt to the prestige of a new idea and to the stiffness of the test involved in preliminary selection and in the final examination. The success of the College cannot be judged until employers have had time to prove the value of its products by experience. The average quality of the students from the point of view of the commercial employer seemed decidedly high. Their knowledge of English, at any rate in the senior years, was good, and in a large number of cases they came of commercial families. Whether the same quality will be attained as numbers increase, as the inevitable pressure for the lowering of the standard makes itself felt, and the idea loses its newness, depends on the impression the students make on the employers. A greater degree of specialisation in definite directions would probably be an advantage.

Generally speaking, a training in commerce cannot make students successful business men; but it ought to teach them method and give them points of view which should subsequently be of use if they succeed in life.

In any case, the mental training should be no worse and may be a good deal better than that of the ordinary Arts course.

QUEEN MARY TECHNICAL SCHOOL FOR DISABLED INDIAN SOLDIERS, BOMBAY.

Visited 29th November 1917.

This School is housed in a very fine building in Byculla, temporarily handed over for this purpose rent free by the executors of the late Sir Jacob Sassoon. It contains accommodation for 200 men, is well fitted up and has extensive grounds.

The attention of the Commission was drawn to the alleged unsuitability of the artificial limbs provided by Mr. Eyres of the Medical Stores Workshops. Major Hirsch informed the Commission that these limbs in comparison with

the latest type supplied in England were heavy and in various ways unsuitable; in particular, the artificial legs, supplied in cases of amputations high up the thigh, were painful to wear, and the men would not be likely to make much use of them. What was wanted, in the opinion of Major Hirsch, was a man from England who was experienced in the manufacture of the latest type of artificial limbs and who would work at the School itself so as to carry out the constant fittings which are necessary to give a man a really satisfactory limb. Although this is not a point on which the Commission can express any definite opinion, it certainly seemed on examination that, though Mr. Eyres' limbs were well made, their design was distinctly inferior to that of the latest limbs from Roehampton, and the idea of having an expert actually attached to the School itself seemed commendable. The Commission recognise, however, that the collection and instruction of a staff of skilled artificers is an exceedingly difficult matter which will take a long time to bring about. A possible course, which might however be strongly objected to by Mr. Eyres, would be to have the expert attached to the School, but confining himself to helping Mr. Eyres with the latest designs, and carrying on with the help of a very small staff the necessary fitting operations at the School.

The Commission saw some of the various classes of work which the School is attempting to teach disabled soldiers. Great difficulties must have had to be overcome in inducing men of the castes from whom the Indian army is recruited to take to employments of this kind. The most successful attempt has been made in the direction of tailoring. Knitting by machinery, fitting and turning, artificial flower making, oil-engine driving, motor-car driving, agriculture and poultry farming were also among the subjects.

With regard to knitting, artificial flower making, agriculture and poultry farming, the co-operation of suitable agencies in the areas where the men will carry on these employments is a prime necessity. This seems specially the case with knitting and poultry farming: a market has to be organised, a small amount of finance arranged and the technical difficulties, which are bound to occur when a man starts work on his own account, overcome by the help of locally available expert advice. An attempt was made to start the use of knitting machines on a large scale in Bengal some years ago, but the Commission understand that, owing to the difficulty found in keeping the machines in order, what was originally a very promising scheme proved to a large extent a failure. This is more likely to be the case with men who are unable to get about and are usually residents of villages. The extensive use of sewing machines in India would be impossible but for the elaborate local organisation maintained by the makers. The same remark applies to poultry farming with imported species, which requires very special attention if success is to be attained. With regard to agriculture, there are not very many forms of this in which a knowledge of improved methods will enable a man to show profits over the ordinary methods, with the possible exception of fruit farming for which considerable capital is needed. Certain types of disability, however, would not disqualify a man from serving as demonstrator in a provincial Agricultural Department, a class of employé for which there is an increasing demand.

For all these reasons there seems an urgent necessity for close co-operation between the Committee here and the departments of Government or other agencies up country where the men will be living on their return to civil life. The Committee does not contain a member with any special knowledge of cottage industries, and it would appear extremely desirable to obtain the help of such a man in Bombay itself with a view to the selection of the most promising types of subjects for training. On this point the Committee could no doubt also obtain the advice of provincial agencies with whom, as has been already pointed out, they ought for other reasons to get into touch. The Commission are not aware whether any attempts have been made to teach the disabled soldiers any form of textile mill work. Mills exist in several centres in the north of India, and several of these are engaged on important army orders, particularly the Dhariwal. It may be the case that men of the sepoy class object to working in mills, but the suggestion is worth looking into.

The School has so far been financed by public subscriptions which have hitherto amounted to Rs. 2½ lakhs, of which Rs. 1¼ lakhs have been spent. If the School is to continue to work after the war, and there is every reason why it should, it seems to have a special claim on public assistance. The sources from which subscriptions might be raised at present would quite possibly be increased, if the proposal made above that the Committee should put itself in touch with local organisations were taken up.

ROSIN AND TURPENTINE FACTORY OF THE FOREST DEPARTMENT, GOVERNMENT OF THE PUNJAB, JALLO.

Visited, 9th December 1917.

A note* on the working of the factory was kindly supplied by Mr. Gibson, the officer in charge. To the particulars supplied in that note may be added the following facts. Mr. Gibson is the Forest Divisional Officer at Simla, and he only visits the factory at intervals. The officer in immediate charge is a ranger on Rs. 80. Mr. Gibson had examined the manufacture of rosin and turpentine in several different countries, especially France and Russia, before these works were erected under his supervision. The French process has had to be modified to suit Indian conditions. Special attention may be drawn to Mr. Gibson's remarks in his note regarding the sale policy adopted by the Forest Department and to the very large profits which are being made at the existing sale rates. No information was available to Mr. Gibson regarding the bazaar rate at which the product of the factory sold in Calcutta or Bombay.

Note on the Government of the Punjab, Forest Department, Rosin and Turpentine Factory at Jallo, North Western Railway, Punjab. (10 miles East of Lahore on main Lahore-Amritsar line) by Mr. A. Gibson, Deputy Conservator of Forests, Simla Forest Division, dated 10th December 1917.

The factory commands the present output of crude resin from the Rawalpindi and Kangra districts, Punjab, and can ultimately command output of the Hazara district, North-West Frontier Province, and if required, the Kashmir, Chamba and Patiala States. Present yearly distillation of resin, 22,000—23,000 maunds. Daily capacity of plant (working night and day, October to March yearly) 15 charges or nearly 180 maunds crude resin. Capacity of plant 35,000 maunds per annum. Possible expansion in Punjab and North-West Frontier Province with Native States as above, up to 100,000 maunds, and possibly more. (British districts only 50—60,000 maunds.)

Capital cost of Jallo Rs. 1,10,000. Gross revenue to date over Rs. 6 lakhs (30 months' working).

Output of crude resin in Punjab and United Provinces for year ending 30th June 1917, about 75,000 maunds, yielding about 52,000 maunds of rosin or colophony and 130,000 gallons of turpentine.

Pre-war imports (mainly American *vid* United Kingdom) up to 1912, annual average, rosin 81,000 maunds, turpentine 220,000 gallons.

Value of Indian rosin and turpentine for year ending 30th June 1917, about Rs. 11 lakhs.

For all practical purposes resin can be looked upon as a solution of rosin in turpentine oil. Process consists of separating the two by steam distillation. Plant at Jallo is French (Mr. Ropar's patent Bordeaux) modified to suit the resin of Pinus longifolia (patent being applied for by Mr. A. J. Gibson on receipt of Government sanction).

One maund of crude resin yields at Jallo 70 per cent. by weight of rosin (28 seers) and 2 gallons of turpentine oil. Bhowali (United Provinces) plant is not so efficient.

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* Printed below.

On an average 1,000 blazes on the trees yield 55 maunds resin in the tapping season March to November annually. An acre of forest yields 25 blazes on an average.

(For further details see pages 42—48 of my note in pamphlet "The work of the Forest Department in India," edited by Mr. R. S. Troup, I.F.S., 1917.)

Control of manufacture and products is by weekly reports and by monthly analyses by myself at Jallo of the control samples. An ex-departmental chemist-manager is required. For rosin tests are :—

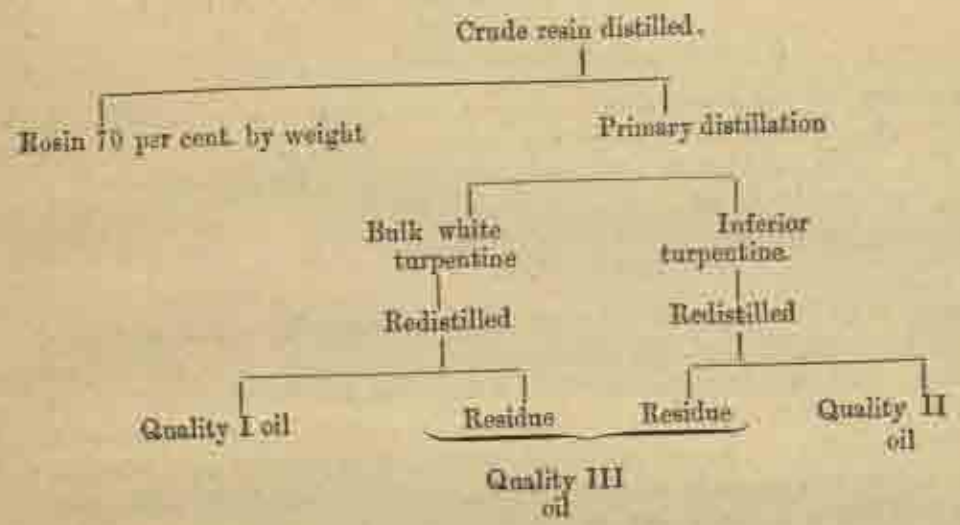
(1) Clearness.
(2) Breaking with conchoidal fracture showing dryness and absence of turpentine oil.
(3) Lack of stickiness, shewing dryness and absence of turpentine oil.

For turpentine tests are (Quality I) :—

(1) Water—white colour.
(2) Specific gravity, generally 0·865.
(3) 10 c.c. to evaporate over water-bath under 2 hours with no appreciable residue.
(4) Tests for absence of resin and other acids with K. O. H., etc.
(5) Fractional distillation, 90 per cent. to go over under 170°C.

For lower qualities lower standards are accepted.

The following chart shows the process at Jallo :—



Quantities.—

Bulk white	1·7 gallons	Quality I	1·50 gallons.
Inferior	0·3 gallon.	Quality II	0·25 gallon.
		Quality III	0·10 ,,
		Loss in redistillation	0·15 ,,
	2·00 gallons.		2·00 gallons.

Sale arrangements.

In hands of United Provinces with agents in Calcutta, Bombay, Madras and Karachi working on a commission basis: the policy adopted in fixing market rates is not known to me.

Current rates f. o. r. Jallo are :—

	Rs.	a.	p.	
Resin (small demand for medical purposes) . .	13	0	0	per maund.
Rosin	10	0	0	"
Quality I turpentine	4	4	0	per gallon.
" II "	3	4	0	"
" III "	2	0	0	"

This gives a gross revenue of Rs. 20 per crude maund distilled and an expenditure of Rs. 8. Profit 150 per cent.

In peace time we count on a gross revenue of Rs. 8 and an expenditure of Rs. 6 or 33⅓ per cent. profit.

Main uses of products.

Rosin—

Paper concerns.

Soap concerns.

Cheap varnish.

Shellac adulteration.

Turpentine—

In the paint and varnish trades and for cleaning purposes, also in medicine for liniments, poultices and embrocations.

NORTH WESTERN RAILWAY WORKSHOPS, LAHORE.

Visited 11th December 1917.

The system served by these shops covers about 5,000 miles of track. In addition to the work required for the upkeep of this system, the shops are also manufacturing a large number of articles of military use, for export as well as for the military services in India.

Carriage Shops.

These employ a staff of some 4,600 men. The subordinate supervisory staff consists of about 14 foremen and 27 chargemen. There are also about 100 *mistries* who draw from Rs. 1-10 to Rs. 3-8 a day. The shops' enclosure covers an area of 195 acres. Only about 100 hands have housing accommodation provided by the company. These are largely men whose presence is continuously required on the works, such as chowkidars, etc. The rest of the hands live in the city and come in every day by a special workmen's train.

In ordinary peace times, one year's supply of wood in scantling and about 4,000 tons in log are kept in stock. It is said that difficulty is felt in respect of the supply of properly seasoned timber. Until recently, considerable use was made of Oregon pine imported for flooring and side planks in carriages. This material was not entirely satisfactory. It is now being replaced by local Indian timbers such as deodar. The quality of these also is not quite satisfactory. The cost both of deodar and of Oregon pine at the works was Rs. 2 per cubic foot in the log. The carriage shops have their own foundry and metal-work shops, which have made a certain number of the tools required in the shops. Files are being recut by hand. The men employed are receiving from annas 13 to Rs. 1-10 a day. The shop foreman got this work started ; he is drawing Rs. 350 per mensem, and had had previous experience of file cutting. The same work is being done on a larger scale, with the help of machinery in cases where this is possible, in the loco. shops.

There are no Indian foremen or chargemen employed in these shops, though an Indian is said to be holding the post of carriage examiner on Rs. 150. The officer in charge of the shops informed us that he had recently engaged a Mahomedan on Rs. 150 per mensem who had been trained at home, where he was earning £3 a week during war time. This man appeared to be of the educated type. He was working at home as an electrician, but did not

care to stay with the North Western Railway. He was considered by our informant as fit for the post of chargeman. The apprentice system is the same for the carriage shops as for the rest of the works. A description of it is appended at the end of this note. These shops appear to have been erected in 1910.

An interesting feature of the work was the building of aeroplane propellers in five thicknesses of wood. This necessitates a special class of glue for the manufacture of which research work seems required.

Loco. Shops.

These shops employ at present about 3,400 hands though the full complement is 5,000. They were erected in 1914. They are at present deficient in respect of machine tools. The estimate for buildings having been exceeded, it was found necessary to economise in respect of the machinery. Moulding sand is at present obtained from two separate places in the Saharanpur district, one of which yields sharp sand and the other loamy sand. These are mixed together. A good deal of work was going on in connection with the comtemplated replacement of coal by oil as fuel in locomotive engines. The works employ 13 foremen, and there are one Indian assistant foreman and some Indian chargemen. We were informed that a system of bonus work had been introduced in substitution of piece work. Under this system the man received a proportion of any savings he effected in time below a certain fixed standard. The reasons for the change apparently lay in the undesirability of allowing men of a certain class to earn wages a great deal in excess of the standard average for their class, at the expense of some degree of physical deterioration. The loco. shops' enclosure covers an area of 125 acres.

Stores Department.

The making of clothing for the staff is carried on in connection with this department. A certain amount of work is also being done on military requirements. A master tailor on Rs. 350 a month is in charge. The markers-out receive Rs. 15 to 30, and the *darzies* work on contract, at so much per so many garments. A printing works is also attached to the Stores Department. They are fully fitted out with linotype machines, automatic ticket-cutting and printing plant, etc. Difficulty was experienced in obtaining the proper type of cardboard for tickets under war conditions. A substitute was being provided by building up cardboard from a number of thicknesses of ordinary paper obtained from the Calcutta paper mills.

Signal shops.

The inspection was confined to the work being done by the engineer-in-charge in obtaining supplies of saddlery, small metal work, etc., from local artisans. In some cases small drop forgings were made over to these men from the works, but generally the men themselves completely manufacture the various articles. Standard samples are exhibited, and the workmen are required in the first instance to put in a specimen article. On this being passed an order is given to him against cash on delivery. In all cases but those of articles which entail comparatively large expenditure on raw materials, it is believed that the workmen were able to finance themselves. In the latter class of cases the help of the local middlemen is required. No advances are given. Leather articles are turned out by the local tanneries as well as by the *moochis*. The necessary testing is done by the subordinate staff of the shops, with the help of a Government leather expert.

Mr. Scott, the officer in charge of the shops, informed us that he had one Indian foreman on Rs. 300 who, it is interesting to note, was the son of a man employed in the Lahore Arsenal under Maharaja Ranjit Singh.

General.

The power is electrical, created from a central generating station of which the maximum load is 2,100 k.w. and the average load is about 1,415 k.w. The system of training in these shops presents the same features as in other railway shops seen by the Commission. The usual distinction is made between the pay

granted to European and Anglo-Indian apprentices on the one hand and Indian on the other. No attempt is apparently made at present to turn Indians into anything better than a superior type of artisan. The present draft rules which are under consideration represent the fourth or fifth attempt to devise a system of training for Indian apprentices. There are about 46 European and Anglo-Indian apprentices at present, but a hostel is being built to accommodate 70. Technical instruction is given entirely by the foremen and the leading hands under whom the lads do their practical work. Great care is taken to keep this instruction in close touch with the daily work done by the boys. Judged by the copy of a letter from one of these youths at present working in England, the system of instruction in respect of Europeans and Anglo-Indians is successful. Special encouragement is given to these to put in a couple of years or so at some leading English mechanical engineering concern.

THE RAILWAY TECHNICAL INSTITUTE, LAHORE.

Visited 11th December 1917.

The name of this school is somewhat misleading. It has no connection with the Railway. It is managed by Government, and the name 'Railway' is apparently due only to the fact that a certain proportion of the pupils go on to the Railway shops as literate Indian apprentices. The school was established in 1889 and, with the exception of a small class for the blind, confines itself to instruction in carpentry and metal work. It contains about 400 boys. The sons of artisans are admitted free and others pay fees. There is no definite rule as to the ages at which boys are taken. The age at which they enter determines the class and work with which they begin. Before leaving, the students pass an examination known as the "Industrial Middle School Examination" which is conducted by the Inspector of Industrial Schools. Some of the ex-pupils go to the School of Art. A number become teachers. Some go to ordinary industrial concerns, and some to Railway shops which take them in as literate Indian apprentices, allowing them to begin two years in advance of the ordinary pay and position of such men. Some of the ex-pupils are drawing Rs. 50 per mensem in the Railway shops after about ten years' work. Others are working as carriage examiners on Rs. 70. The school seems more successful in the production of draughtsmen who receive comparatively high pay. The Indian apprentices in the Railway Workshops also come to this school to learn English and mechanics. The Railway Workshops provide only manual training for Indians at present. The boys are not paid for the work they do in the school, and in other respects do not work under ordinary commercial conditions. They put in 36 hours a week in actual manual work. Ten per cent. of them receive scholarships.

Brief note on the Government Railway Technical School, Lahore, by Mr. M. Crosse, Inspector of Schools, Lahore Division.

Admission.—The school is open to boys from five years of age, but the average age of admission is between six and eight. Boys may be admitted from non-industrial schools at any age, and such are put into a special class until they make good their deficiency on the technical side.

Classification.—(A) The ordinary school works through 3 stages as shown below, with subjects and working hours per week :—

Stages.	General Education.	Hours.	Technical.	Hours.
Lower Primary—				
I	The 3 R's . .	22	Paper and Cardboard folding.	8
II . . .	Do. .	20	Cardboard and Clay Modelling and Drawing.	16
III . . .	Do. and Geography.	20	Do. do.	16

Stages	General Education.	Hours.	Technical.	Hours.
Upper Primary—				
IV . . .	The 3 R's and Geography.	15	Wood or Tin and Iron work and Drawing (Model, Geometrical and Scale).	21
V . . .	Do. .	14	Do. do.	28
Middle—				
I	English, Urdu and Arithmetic.	12	One of the following:—Pattern-making, Tin and Copper work, Iron work, Machine work, Wood work, Moulding and Estimating, Drawing (Model, Geometrical and Machine).	36
II . . .	Do. and Science.	14	Do. do.	34
III . . .	Do. do. .	14	Do. do.	34

This represents what the school now does in consequence of a development from more literary to more manual work.

Special Advanced Classes.—(B) Apart from the foregoing is a five years' course for literate apprentices of whom at present there are 17. The majority are young men who have received their general education elsewhere. This class is open to all literate apprentices, whether they have passed through this school or not. They are taught for two hours in the school and work for about four hours in the workshops. The course consists of English, elementary algebra, arithmetic, mensuration and mechanics.

It is proposed to reduce the apprenticeship to three years in the case of pupils who have completed this school course, and to raise the present scale of pay from 5 annas 4 pies to 12 annas per day.

Numbers and Creed.—There are 403 boys in the school classified as follows:—

Muhammadans 263; Hindus 82; Sikhs 55; others 3; 80 per cent. belong to the artisan class.

Fees.—Artisans are free, others pay fees ranging from one anna to two rupees.

Scholarships.—There are 20 scholarships of Rs. 2 per mensem each in the Upper Primary and 24 of Rs. 3 each in the Middle. They are awarded on the results of an examination in both general and technical subjects in the 3rd and 5th Primary classes, and are held throughout the Upper Primary or Middle courses, unless the holder fails to pass the annual test.

Staff.—Excluding the headmaster, there are 8 teachers on the general side who are chiefly men who have undergone a successful course of training in the Central Training College. Their pay varies at present from Rs. 20 to Rs. 90 per mensem. On the technical side there are 13 teachers who have mostly been trained in the Mayo School of Art and the balance in the Railway Workshops. Except the machinery instructor, who gets from Rs. 70 to Rs. 90 per mensem, the pay of the rest ranges between Rs. 25 to Rs. 40.

As regards the headmaster, he is a graduate of the Punjab University, was trained in the Central Training College and holds a first-grade senior Anglo-vernacular certificate. He is a member of the Subordinate Educational Service, and his present pay is Rs. 190 *plus* an allowance of Rs. 30. He began his practical training in this school as an assistant and has held his present post for 12 years, developing his knowledge of technical work from year to year, and the

school under his intelligent control has steadily developed. He has proved a thoroughly capable headmaster of this type of school.

Cost of the school.—The whole cost is borne by Government, and the budget provision for 1917-18 was Rs. 7,206 for contingencies, including menials, and Rs. 13,692 for staff.

Employment of pupils.—Practically every boy of this school who does not wish to study further in advanced institutions, whether he has completed the course or not, readily finds employment. It has been found impossible to keep in touch for long with old boys, but in nearly every case it is known, whether they leave to take up an advanced course of instruction or to get employment, that a large proportion of the Carriage and Assistant Carriage Examiners on the North Western Railway are passed students and some are known to be similarly employed on the Oudh and Rohilkhand Railway on salaries beginning at Rs. 16 and rising to Rs. 150. Others hold posts as draughtsmen on salaries from Rs. 25 upwards. Others are employed in the Railway workshops or in private concerns and readily get, to begin with, Rs. 25, and rise to Rs. 40 at least.

THE GOVERNMENT CENTRAL WEAVERY, LAHORE.

Visited 14th December 1917.

The Government Central Weavery at Lahore was started in 1914 as an experimental institution for a period of 4 years at first. The objects of the Weavery are as follows:—

(1) to experiment on the improved hand looms and their accessories;

(2) to adopt improved methods to weave the various fabrics already woven in the Punjab;

(3) to give technical and other help to the weavers and to push the improved methods among weavers by means of travelling exhibition;

(4) to train weaving masters;

(5) to train in improved methods of dyeing and specially to carry out research in indigenous dye stuffs;

(6) to introduce small cottage industries amongst the poor but respectable women and widows, so that they may become independent wage earners and be useful members of society; and

(7) to train and experiment in hosiery with improved machinery.

The Weavery is in charge of a textile assistant to the Director of Agriculture and Industries, who is assisted by a lady superintendent, a dyeing master, a supervisor, a hosiery mistress, a mechanic and a certain amount of labour staff. The dyeing school was added to it in 1916. The work of the Weavery is being conducted by means of the following departments:—

(*a*) Weaving department.

(*b*) Hosiery department.

(*c*) Zenana industrial school.

(*d*) Dyeing school.

(*e*) Travelling exhibition.

(*a*) The chief point in the working of the weaving department is to find out a more suitable loom for the village weaver, and also one for small workshops. So far, experiments have been conducted with the following types of looms:—

(1) Old Desi Khaddi.

(2) Thukral Weavers Delight Fly-Shuttle loom.

(3) Serampore Fly-Shuttle loom.

(4) Salvation Army loom.

(5) Hattersley's Domestic Automatic loom.

The experiments on the old Desi Khaddi have been made only for the sake of comparison with other improved types of looms. The cost of the different looms is as follows:—

	Rs.	Rs.
Desi loom	10	to 15
Thukral Fly-Shuttle Pit loom	20	„ 35
Serampore Fly-Shuttle loom	40	„ 75
Salvation Army loom	75	„ 125
Hattersley's Domestic Automatic loom	225	„ 375

Of all these looms it seems that the Thukral Fly-Shuttle Pit loom has proved to be the best for a village weaver. It is cheap in cost, and simple in construction. It can work with or without any warp beam. There are no iron parts in it, so that any damage can be easily repaired by the village carpenter. It can weave cloth from 20 to 72 inches in width and can run on a speed of nearly 100 picks a minute. Moreover, it can weave equally well the single yarn, the desi hand-spun yarn and the two-fold yarn. Its outturn, in comparison with the Desi loom is double up to 27 inches width of cloth. In larger widths it gives from 3 to 5 times the outturn of the Desi loom.

The Weavery has also conducted experiments in improved preparatory machinery for reeling, winding, sizing, etc. Practical demonstrations are given every winter in the working of the improved looms and methods in the various districts of the province. So far, 5 persons have been trained, and are occupying posts of weaving masters in small hand-loom factories.

(*b*) The hosiery department has so far been able to train about 15 persons.

(*c*) In the zenana industrial school instruction is given in freehand drawing, hand embroidery, machine embroidery, drawn-thread work, chikan work, thread-ball winding and the winding of yarn. About 25 women have been so far trained in this school. In order to remove the difficulty in finding employment for them, a sum of Rs. 2,400 was raised by public subscription, and the 'Home Industry Promoting Society' was started, to which Government gave a grant of Rs. 2,000.

(*d*) The dyeing school was added in 1916 with a view to teach improved methods of dyeing to dyers, and generally to teach dyeing. About a dozen students have been thus trained. The school has also made a number of experiments with indigenous dye stuffs with considerable success. A good deal of extension and encouragement seems to be necessary in this direction.

In addition to maintaining the Weavery, Government have endowed a number of scholarships. 20 scholarships of Rs. 5 each are sanctioned for the zenana school and 6 scholarships of Rs. 12 per month each for the dyeing school. Government have also granted a sum of Rs. 1,000 per annum for the travelling exhibition. The school, however, still seems to be in need of a well-equipped laboratory.

THE MAYO SCHOOL OF ART, LAHORE.

Visited 15th December 1917.

A note* by the Principal is appended. In addition to this, it may be mentioned that about 50 per cent. of the pupils go out as teachers. These posts, although they only carry the low pay of Rs. 35, seem very attractive to the general run of the students. Most of the rest work as independent craftsmen or employés.

2. The following suggestions ought apparently to be adopted, if the School of Art is to fulfil the programme laid down by the superintendent:—

(1) An organisation is required for keeping the staff in touch with passed pupils who are working as craftsmen, in order that assistance and advice, both in technical matters and in regard to the marketing of their work, may be afforded, if necessary.

Printed below.

(2) Steps should be taken to organise a market for the products of ex-students, somewhat on the lines of the similar institution in Cawnpore.

(3) Boys who intend leaving the school to work as craftsmen should not be allowed to do so, without a proper provision of the improved tools which they have learned to use in the school. The cost of these would vary very widely in individual cases, and the equipment in each case should be left to the decision of the superintendent. The latter suggests that the cost of the tools may be treated as an advance recoverable in instalments spread out over one or two years. The scholarships granted were apparently not sufficient to admit of any portion of them being held back as reserve pay to purchase a kit of tools, as is being done in the School of Handicrafts at Nagpur.

All the above suggestions involve the maintenance of extra establishment to carry them out, and the superintendent is inclined to doubt whether he would have sufficient time to control them. Were the School, however, attached to a Department of Industries, the needful organisation could be maintained and kept in close touch with the working of the School, as part of the general work of such a department.

Note on the Mayo School of Art by the Principal.

"The Mayo School of Art has earned a reputation for high-class craft work and design. Mr. Lockwood Kipling, C.I.E., is responsible for having started it on its career, and, by his sympathy with Indian crafts, his ability as a designer and modeller, and his strong personality has left a mark upon the School and a reputation and friendship with all his staff and students, some of whom still remain and are doing excellent work in the School. In other words, he originated in the School by his own ideals an atmosphere of craft enthusiasm which, I consider, is an essential weapon in the armoury of all teachers.

"As a result of such a reputation as the school had earned and in consequence of the fact that it was doing better work than could be got elsewhere in the province, it began to receive orders from Government departments and to take contracts for interior decorations, furniture, etc., designs for buildings and, even later, construction work, such as the whole of the designs for the 1911 Durbar Amphitheatre work with all the plaster decorations thereto.

"While it may be acknowledged to be an excellent thing for the students of such an institution to have such practical experience, at the same time it had definite disadvantages.

"*First*.—It restricted the energies of the School from flowing into wider channels as Government demand was confined chiefly to carved wood work and decorated plaster work, whereas they might have been directed towards the development of other art crafts.

"*Second*.—It gave none of the discipline of commercial conditions to the students, as they were not paid, and the work was not paid for at commercial rates, as much of the labour was either free or provided by the staff of the school already under Government service.

"*Third*.—The training of the students suffered as instruction and progress were made subservient to the demands of the moment, by which all available students had to be roped in for work which might be quite outside their course.

"The result of these effects was first a steady decline in the number of students owing to inability to obtain employment, because (secondly) the students could only carve and model, and both these crafts have of recent years a very moderate demand, outside a few wealthy employers.

"Coming to the present time, the development of the School has been during the last six years in a direction tending to remedy these evils; new workshops have been built with power machines for cabinet-making, blacksmithy and fitters work, and copper, brass and silver work.

"A photo-lithographic studio and engraving rooms with up-to-date appliances have been provided and a large carpenters' shop for elementary students opened.

"In order to give better chances of good discipline and honest work, an eight hours day has taken the place of six hours and a works overseer has been appointed to supervise the work and design of both students and *mistris*.

"In order to raise the standard of work of the students, each shop has working *mistris* provided, engaged to do special work as an example or to work with the students if their work is of a special character.

"The pay of most of the teaching staff has been greatly increased, partly on account of their pay having been far below what could be earned in the bazar by skilled workers and partly in consideration of increased hours of work.

"It has also been laid down and carried out that all newly appointed craft teachers should hold non-pensionable posts with increased pay in lieu of pension. A maximum of Rs. 60 per mensem has been sanctioned, but my proposal was for Rs. 60—5—80 per mensem.

"A further proposal was that contract work should not be done, but, in order to maintain the advantage of working to order, specimens should be made as examples to bazar *mistris* and designs and working drawings supplied. This alone is now in force and working well, as it brings the school work into direct contact with the craft worker, without competing with him.

"The surplus work of the School is now being circulated to industrial schools of the province, with the object of improving their standard of design and finish. When these schools also develop, much more work may be usefully supplied to them that now has to be sold privately.

"As regards the result of the scheme which, as a whole, has not been working more than three years, I can see that more work is turned out and the general quality is much higher, while during these years a small steady improvement in the number of students is shown. But I am sorry to say that the one great defect is the failure of the student to give eight hours work value in the day. This is proved by the fact that I have sent students to the Carriage Workshop, Lahore, and the Canal Workshops, Amritsar, and though they could do the work allotted to them the quantity of work they did was only sufficient to give them a starting pay of twelve annas a day. Whether training in a technical school can ever overcome such defects, which are not peculiar to India only, is doubtful, but it is undoubtedly emphasised in India to some extent by the family system obtaining, which tends to give lazy youths undue freedom and hinders that speeding up which necessity forces upon the European youth. Defective primary education may also have its share in this lack of discipline of mind and body so noticeable in the Indian working man.

"Coming to the future work of an institution like the Mayo School of Art, I think it ought fairly to be required of it that it should be equipped to be a leader in all those crafts into which art and design enter largely. It should be primarily a school of design, carrying out in practical work its designs, because only the practical worker can design economically. Design is most important because, as I see it, there can be no future for the art crafts of India unless their individuality is preserved, and I do not see how this can be done except by inspiration obtained through a Government central institution. Japan fully realises the value of national individuality and, with all its modernity, its craft work has lost nothing of its character. I think I shall not be wrong in estimating that there are one hundred objects of Japanese craft work sold in England to one of Indian workmanship, and certainly I should say this is so in America.

"It is possible that the Punjab may never be a big industrial province by having large manufacturing firms, but I see no reason why it should not be a centre of cottage industries. The hand skill is here, and many small industries already exist, and we know that Wurtemburg developed in two or three decades from a purely agricultural country, with no previous knowledge of industries, into a highly skilled industrial community.

"Such an industry as cotton printing with hand blocks has, I believe, survived in Switzerland against all the competition of power-printing, owing partly to cheapness of labour, which we have here, and partly to the number of colours obtainable at small expense. The Manchester School of Technology sent a man out here three or four years ago to collect Indian cotton prints in order that they might copy them by machinery; he was here nine months and he told me he had a magnificent collection, but he thought it hopeless to attempt to copy them as the cost would be excessive.

"In the small cotton-printing department of the School of Art we could sell dozens of almost anything we print, where we now sell samples, if there were any organisation to bring the work into contact with the buyers.

"This is the sort of pioneer work that should be expected of a School of Arts and Crafts."

LAHORE CENTRAL JAIL.

Visited 15th December 1917.

The jail convict population was 2,010. The earnings, per head, during the preceding year were Rs. 15. No extra male labour was going on in the neighbourhood of the jail, though a labour force had been sent from the Central Jail to Khewra Salt Mines, and another from the Borstal Jail to Dhariwal.

In view of the complaints which had been received regarding the competition of jail with private industries, the Commission paid special attention to the working of the jail press. The machines were run by two steam and one oil engine. Each of these had a paid driver in charge, although several of the convicts had learned to drive satisfactorily. Only a small amount of typographic work was done for the jail itself; the rest of the work was lithographic and consisted in the printing of forms for Government departments. 250 men were employed in the press.

The rules* regarding the price at which jail manufactures are to be invoiced to Government departments, together with specimen† invoices, were obtained. Generally speaking, the charge made to Government is on the basis of the cost of the skilled and unskilled labour employed, together with depreciation and cost of raw materials. If, however, this rate works out lower than the market rate, the latter is to be charged. It is obvious, therefore, that proper precautions are taken to prevent undue competition with private concerns; and, in reference to the complaints received by the Commission regarding this question of printing forms for Government, it has at all times been recognised as necessary for Government to own its own press, quite apart from jail printing.

The Commission also saw tent making. This industry was started, so far as the Punjab is concerned, as a jail industry. The jails make tents for all civil departments in the Punjab and also for war purposes. This class of work necessitates labour of a very varied kind and is, therefore, welcomed by the jail authorities. There can be no objection to tent making going on during the war, in view of the extreme pressure on private tentmaking concerns; but in ordinary times, care would obviously have to be taken that jail-made tents are not invoiced at unfairly low prices. The rules appended seem to provide for this.

There is very little carpet making in the jail at present. This industry was started and built up in the province as a jail industry. A private carpet factory started and took over all the ex-convicts who had learned the work, together with the Deputy Superintendent who was mainly responsible for the designing and manufacturing. So far, the jail has, therefore, been of considerable assistance to private industries, though perhaps not very willingly.

We were informed that ex-convicts obtained employment in the industries which they learned in the jails, especially that of engraving lithographic stones; but no record exists as to the subsequent employment of ex-convicts, owing to the absence of any Prisoners' Aid Society.

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* Printed below—extract from the Punjab Jail Manual.
† These do not illustrate the method of calculating charges, so are not printed.

Borstal Jail.

The convict population consisted of 1,090. The number of officials reached the high figure of 127, doubtless including convict officers. Any convicted prisoner sentenced to over 4 months' imprisonment, and up to 23 years of age, is sent to this institution, which was started 4 years ago. It does a fair amount of extra-mural labour. In addition to the gang working at the Dhariwal Mills, boys who have learned carpentry are lent out to the Municipality. The convicts are allowed to earn money which they take away with them when they leave the jail. Any convict sentenced to a term of 3 years or upwards has to learn to read and write.

We were informed that a Bill is to be introduced, remedying certain defects of the present law in regard to Borstal institutions.

The Commission were generally very favourably impressed with the comparative brightness of the life in this jail, *e.g.*, the presence of flowering plants and shrubs inside the jail. The physical drill was smartly performed and evidently enjoyed by the prisoners, who had their own jail band. Saddlery and other munitions work was going on, both in this and the other jail.

Extract from the Punjab Jail Manual.

"689. (1) When the requirements of the Jail and other departments have been met to the fullest extent it is possible to meet them, prison labour may be employed in the manufacture of such articles as will be least likely to compete with any local industry, for sale to the public at current market rates.

Manufacture of articles for sale.

(2) Tenders, wholesale and retail, should be dealt with, in preference to consumers amongst the public.

Note 1.—When market rates do not exist or cannot be ascertained the price of Jail-made articles must be calculated and must always include:—

(*a*) the price of the raw materials;
(*b*) the wages of Jail labour, rated according to the wages of free labour of the same class in the neighbourhood and with regard to its inferiority;
(*c*) a percentage for wear and tear of plant; and
(*d*) a percentage on account of profits.

Note 2.—In the case of articles supplied to Government or to the public, the percentage on account of profits may ordinarily be fixed at 10 per cent. on the cost of the raw material and labour; if the prices thus found are below the ordinary rates at which the goods could be procured by the same class of purchasers in the open market, they must be raised to at least such market rates.

Note 3.—In the case of cotton goods, the equivalent of 3½ per cent. (duty) must be added in computing the selling price, unless the result is to raise the rates above those prevalent in the open market.

Note 4.—No order from private persons for goods should be put in hand until half the estimated value is deposited by the purchaser; the balance of the price must be paid on delivery of the goods.

No credit is to be allowed to private purchasers (Jail officials or others).

Note 5.—A price list of the articles manufactured in every Jail is to be prepared and exhibited in the offices. This list must be revised from time to time as may be necessary."

HYDRO-ELECTRIC WORKS, AMRITSAR.

Visited 20th December 1917.

The note below by Mr. J. Ashford describes the hydro-electric works at Amritsar.

Brief note on the Amritsar Hydro-Electric Pumping Installation by John Ashford, Superintendent, Central Workshop Division, Amritsar.

"The object of this installation is to pump water from the sub-soil for irrigation purpose and to replace flow irrigation from canal, the need for the change being the rise in sub-soil water until it seriously affected the health of the inhabitants of Amritsar.

"Its inception was due to Sir John Benton, who, in his inspection note, dated October 16th, 1906, directed the investigation of the possibilities of pumping water from the sub-soil by the aid of electric power developed at canal falls. That note caused a series of experiments to be undertaken, which resulted in the development of the Ashford tube well and pumps, which made this scheme possible.

"Upon the Main Branch Lower of the Upper Bari Doab Canal, there are two falls near Amritsar, two miles apart. The upper one, near the Grand Trunk Road, had a fall of 5'-6" and the lower one, near the Tarn-taran Road, has 4'-0". The scheme provides for deepening the channel between these falls to secure 9'-6" at the upper fall. Before doing this, it was decided to build the power house and instal machinery therein to begin work with the 5'-6" fall and to complete the scheme by deepening the channel at a later date.

"It was arranged that the well and pumps should be located conveniently along the Jatuwal Distributary to replace the irrigation therefrom, using the same water courses. This arrangement is far from ideal as it gave a series of pumping sites, straggling along a considerable distance, but the arrangement was made necessary by the demands of the Irrigation officers.

"A new channel of short length has been cut round the fall to carry the water to the power house, the old fall remaining to act as a spillway. Upon it a footbridge and needle dam have been placed to give control of upstream water level.

"The maximum flow of water in the channel is 2,200 cusecs, but, as this is only for four months in the year, the power house was fitted with turbines to use 1,100 cusecs only, which amount can be had for about nine and a half months in the year.

"As the by-pass channel approaches the power house it divides into three flumes with controlling sluice gates. In each flume is a turbine set consisting of two coupled double turbines of horizontal type. In other words, there are four motors on a horizontal shaft. These turbines revolve at 100 revs. per minute and drive the generators through gearing at 500 revs. per minute. The gearing is of the high class type developed for breaking down the speed of steam turbines. They are machine-cut double helical gears of fuse pitch, enclosed in a case and running in a bath of oil. The bearings of the turbines are self-aligning, ring lubricated bearings protected by steel caissons to keep the silt laden water away from them.

"The generators are of 175 k. w. capacity alternating current 6,600 volts 50 periods. They generate directly at that pressure.

"The switch board is of steel with all parts under high pressure contained within closed cells. The control is remote. Switches, etc., are all oil submerged. There is the usual complement of instruments and cut-outs, including synchronoscope for bringing the machines into parallel before switching in. The station and machines are protected from line surges by Giles valves.

"The turbines are controlled by special oil pressure governors of a new type, designed by the makers in consultation with myself. It is wholly enclosed, and all bearings lubricated with oil under pressure.

"The current is transmitted at 6,600 volts to sub-stations, where it is reduced down in Berry transformers to 550 volts for distribution to the pumps. Each sub-station serves 6 pumping stations.

"The land is divided into areas requiring 1½ cusecs for sixteen hours daily, and to each such area there is one pump. These areas are really too small for the water we can pump, but they were insisted upon by the responsible Irrigation officer, who had no experiance in the possibilities of tube well pumping, and therefore had doubts. This gives a higher capitalization than is necessary.

"The tube wells are Ashford's patent 10" dial with 120'—0" of strainer sunk to a total depth of 100'-0" and are made at the Central Workshop.

"The pumps are of special type of high efficiency, designed and built at the Central Workshop. They have vertical spindles and are submerged below water, thereby needing no footvalves.

"The maximum yield obtained from one tube well is 2·6 cusecs, and the power used is just over 5 h. p. per cusec. The motors at the pumps are 15 h. p. and have a speed of 960 revs. per minute. They are vertical in type, directly coupled to the pumps which have been built to suit. All bearings are specially lubricated, so that there is no need for an attendant at the pumping stations. One man per sub-station with six pumps is able to give all needed attention. Fifteen of these pumping stations have already been built, but when the two falls are fused into one, it will enable 40 tube wells to be brought into use. Part of the power is used at the Central Workshops and drives the machinery there. This uses about 120 h. p.

"The pump efficiencies obtained are as high as 73 per cent, which is considered good. This is without allowing for energy of discharge, the inclusion of which would place the efficiency at 75 per cent.

"The length of distribution lines so far put down is 13 miles. The longest lead from the power station is 5½ miles. There will ultimately be about 35 miles of line, an average of just under 1 mile per pump. The distance between pumps varies from half to one mile."

It is doubtful whether the works will do anything to reduce the level of the sub-soil water, but they at any rate supply water without adding to it. We were informed that the installation, when complete, would pay expenses and interest on capital cost, but details are not available.

HYDRO-ELECTRIC WORKS AT THE NEW EGERTON WOOLLEN MILLS, DHARIWAL.

Visited 21st December 1917.

The woollen mills here, which employ in normal times some 2,000 hands, were started by a retired officer of the Punjab Government, partly on the strength of the hydro-electric power available, partly because Dhariwal was supposed to be conveniently situated for labour and wool supplies. The concern soon failed and was bought up very cheap by the interests controlling the large woollen mills at Cawnpore. The great drawback is that the supply of water is intermittent, owing to closures necessitated by distribution of water and clearing and repairs to the canal. The extent of these closures in an ordinary year is shown in the statement below. The mills therefore have to provide a 'stand-by' plant, actuated by Bengal coal, and the manager informed us that the power costs more all round than the steam power generated at the Cawnpore mills.

The only expenditure incurred by Government was the cost of regulating gates to close down the supply when necessary, which presumably did not amount to more than a few thousand rupees. All the remaining plant was put in by the mills. The availability of the water for irrigation is in no way affected by the use of the water for generating power, as the whole supply of the canal has to be passed over the fall in any case. The water was given free for the initial period; and it was during this period that the original enterprise failed. For the next period the charge was Rs. 10,000, and it is to be raised to Rs. 24,000 next year for some 700 h. p. The mills complained that this charge was unjustifiably high, but said that, as they were dependent on the use of the water, they had to pay it. Their 'stand-by' installation was not quite sufficient to run the whole mills, and it would have been presumably much more expensive to run all the time on coal than on water power. On the other hand, it may be urged that the present company were not the originators of the enterprise, but took it over on very low terms and are a strong and wealthy concern. But it must be admitted that such high terms for an intermittent supply are not likely to encourage other prospective users.

Statement showing number of days in which canal was closed partly or wholly, rendering it necessary to run steam and gas engines.

Year.	Days.
1915	50
1916	45
1917	66

SUALKUCHI WEAVING VILLAGE.

Visited, 6th January 1918.

This village is situated on the banks of the Brahmaputra about 8 miles below Gauhati in the Kamrup district. There are said to be 200 weaving families engaged in making cloths, chiefly from *endi* and *muga* silk. Latterly, Chinese silk has also found its way into the village and is now being used to some extent in place of the indigenous silk.

The *endi* silk yarn is apparently brought into the village as we did not see any spinning going on; but in most of the backyards attached to the weavers' houses there were considerable quantities of *muga* silk cocoons and reeling and twisting was going on. The apparatus employed is of a very primitive type. The cocoons are soaked in warm water, and the threads from half-a-dozen cocoons are reeled into a single thread by simply passing them over a bamboo and along the reeler's arm on to a solid wooden roller. From this roller, the silk is transferred to bamboo swifts.

The silk-twisting process is very simple but very laborious. In the village street, about a dozen bamboo frames are put up about ten yards apart, and unreeled silk stretched over them. Starting from the twisting end, a sort of distaff is attached to the thread. One end is carried across these frames round a smooth bamboo and back again with another distaff attached to it. Small boys set these distaffs spinning, and the amount of twist is regulated by the gradual rise of the distaffs at the reeling end. When a length of silk is sufficiently twisted, the distaff is removed and unreeled silk is attached. The reeler then winds up the twisted silk on a swift till the whole twisted length is so wound up, when a small boy breaks the thread and attaches a distaff and sets it spinning. The silk is therefore twisted in lengths of about 200 yards and there were about six such lengths stretched on each frame.

The weaving is done on ordinary native looms with harness for pattern, weaving such as may be seen in any weaving centre. The cloths turned out are of excellent quality and the patterns are very good. From an economic point of view, the industry is in an extremely primitive state, and the production, per man engaged, is very small. Silk-reeling and twisting machinery worked by hand might very well be introduced. The pattern weaving could easily be done by jacquard harness, and the fly-shuttle loom employed in place of the primitive loom now in use.

We were taken round the village by the weaving demonstrator employed by the Agricultural Department. He had been through a two years' course in Serampore, and he had set up a Serampore cotton loom on which a man was working with very little skill. He said that the people of the village took no interest in his so-called improvements, and they probably showed a certain amount of commonsense thereby.

There seems to be but little doubt that the industry could be enormously improved, both as to the reeling and throwing of the silk and the methods of weaving. If any steps are taken to develop the silk industry in Assam, from the outset the work should be divided between two thoroughly competent experts, one a sericulturist to deal with the production of silk and the other with a knowledge of modern processes of manufacture. The *muga* silk is easily

reeled, and there should be but little difficulty in adapting ordinary throwing machinery to the production of a first-class thread. It would not be desirable to carry out experiments to determine the best type of machinery in the village. This should be done elsewhere, and, when the mechanical appliances have been adapted to the work to be done, demonstrations should be made in the village. The sericultural problem is doubtless a much more difficult one than the manufacturing, and a much higher type of expert would probably be required.

There are in Sualkuchi two trading firms, the Assam Silk Trading Company and the Assam Silk Cloths Manufacturing Company, to which the weavers dispose of the major portion of their production. They seem to be well organised, and have issued, in English, printed price-lists of the goods they sell.

A great deal of the silk weaving in Assam is a domestic industry carried on by women even of the higher classes. Such weaving we were not allowed to see, and the products of the domestic looms are mainly for domestic consumption, though in some villages, the weaving women sell their cloths. In Sualkuchi, the whole of the spinning, reeling and weaving work is done by men, and the women are not employed. The industry seems to be a very promising one for development by the application of scientific methods of sericulture and by the introduction of modern silk machinery.

THE BOMBAY BURMA TRADING COMPANY TIMBER YARDS, RANGOON.

Visited 23rd January 1918.

This company owns saw mills on both sides of the river in Rangoon and deals with about forty per cent. of the Burma teak trade. The Commission first visited their timber yard on the south side of the river, where an exhibition was given of the methods of handling teak logs by means of elephants. In a well-equipped saw mill provided with cranes and over-head travellers, these useful animals are no longer employed, but they are still indispensable in the forests to bring the timber logs down to the streams. The Bombay-Burma Trading Company employs approximately 2,000 elephants in the forest areas worked by them, and their live-stock in their latest balance sheet is valued at well over 40 lakhs of rupees.

For forest work, Indian elephants are looked upon with disfavour as it difficult, and often impossible, to train them. Formerly, Burmese and Siamese elephants could be obtained for from Rs. 2,000 to Rs. 3,000 a head ; but now, a first class animal costs Rs. 8,500. The records of the company show that the working life of an elephant averages 25 years.

The teak forests in Burma cover enormous areas, and the preparation of the wood for the market is concentrated in Rangoon, the logs being floated down the river in rafts. Between the time of felling a tree and its arrival at the timber yard, a period of four years occurs, and we were informed that about ten per cent. of the timber is lost on the way.

The saw mill inspected by the Commission was situated within the Municipal limits of Rangoon on the north side of the river. All the wood comes into the yard and leaves it by water, no use being made of the adjacent railway. The logs are handled by over-head travellers, and a very considerable range of storage sheds are provided for baulks and scantlings intended for export to Europe. Owing to the war and the consequent scarcity of shipping, large stocks of wood have accumulated and the mills are now only worked 4½ days a week.

In this timber yard, there are four large circular saws and four frame saws for breaking down logs. At the present time, the machines are driven by steam engines from a battery of three boilers using teak saw-dust for fuel. A central electric generating station is in course of construction. The plant has been installed and consists of two 350 k. w. alternators driven by Belliss and Morcombe steam engines. Working at its full capacity, this saw mill is able to deal with about 7,000 tons of teak logs a month. The efficiency of conversion ranges round 85 per cent. 88 per cent. being considered very good and anything below 82 per cent. very bad. There is no recognised standard set of scantlings,

and the logs are cut up either to comply with specific orders or to the stock sizes mostly in demand which can be obtained from the logs with the least waste.

Besides the breaking-down saws, there are cross-cut saws and a large number of small circular saws to deal with slabs, log ends and other products from the breaking-down saws. Band saws have been tried; but as the logs have been floated, even after washing they still hold a good deal of mud and fine sand and, as the timber naturally contains a certain amount of silica, this method of cutting up timber has not proved satisfactory owing to the short life of the saws. The only, what may be termed, 'finished articles' produced in the mills were wooden keys for railway chairs and shooks for kerosene oil cases of a special design of the Indo-Burma Oil Company.

There are small workshops for the repair of the plant and a special shop devoted to saw sharpening tools.

The labour employed in these mills is mostly imported from the Coromandel Coast and is under the control, in some instances, of Burmese foremen, these again being supervised by Anglo-Indians and Europeans trained in the country. For many years, there has been no necessity to import men from Europe.

In the mill compound, there is a large range of barracks capable of housing about 700 men. These are built of wood and sub-divided into rooms, each licensed for a certain number of men, usually from 25 to 37. The arrangement appears to be eminently satisfactory for single men. The sheds were clean and the men divided themselves into groups according to their castes and were supplied with cooks by the company. This method of housing emigrant labour of a seasonal kind, where the men are not accompanied by their families, is a perfectly satisfactory solution of the problem.

THE RICE MILL AT PAZUNDAUNG.

(Managing Agents: Messrs. Steel Bros.)

Visited 24th January 1918.

Paddy is the principal crop grown in Burma, and the area under cultivation in 1915 is stated to have been 10,050,000 acres. There is a large surplus available for export, which, in the year mentioned, amounted to 2,400,000 tons of cargo rice. The principal industry in Burma is the milling of rice, and the Inspector of Factories states that in the whole province there are 318 rice mills employing 20 hands or more, with possibly another 50 small mills employing less than 20 hands. The larger mills, mainly in the hands of Europeans, are all situated along the banks of the river and the creeks in Rangoon.

The mill visited by the Commission is the largest in Burma and probably the largest rice mill in the world, the maximum daily output being in the neighbourhood of 700 tons of cargo rice per day. The milling of paddy results in a number of products, samples of which were shown to us on entering the mill. The simplest operation is the separation of the husk from the kernel resulting in the production of paddy husk and rice; but the broken grains of the latter, locally known as 'coodie', are screened off and graded. In normal times, they are exported to Europe for the manufacture of starch. Previous to the outbreak of war, large quantities of Burma rice were exported to Hamburg for distribution over Central Europe and, when necessary, this cargo rice was further cleaned and polished. Where a higher grade of rice is required, a more perfect separation of the husk from the paddy is effected and for the highest grades of all, the clean rice is polished. These operations result in the production of a certain amount of rice meal which, when freight is available, is exported to Europe and used in the preparation of patent cattle foods.

The paddy is brought to the mill both by railway and by river, and, when working full time, about 1,000 tons have to be handled every day. The arrangements for dealing with so large a quantity of material are extremely

primitive and necessitate the employment of a very large number of coolies. Without a detailed knowledge of the working of a rice mill in Rangoon, it is not possible to say whether the installation of automatic machinery for handling the grain would be a profitable investment. The paddy, especially that brought in by the railway, is very dirty and an elaborate installation of cleaning machinery is an essential preliminary to the actual milling. This is effected by means of shaking sieves and aspirators. The clean paddy then passes into the mill and is lightly ground between mill stones whereby a great part of the husk is removed. These machines are called 'shellers' and there were 30 pairs at work in the mill inspected, each capable of dealing with a maximum of a ton and a half of paddy per hour. The product of the shellers is first subjected to aspiration to remove the completely detached husk and then passed over sieves to remove the broken grains of rice. The tailings are treated on gravity separators, whereby the untouched grains of paddy are removed. These are passed back to the shellers, and the rice is subjected to a further decorticating process in what are known as 'hullers.' The hullers are used in a series of two or three. Each machine consists of a rapidly revolving cone, the first in the series coated with carborundum and the second with emery powder. The cone revolves inside a wire casing coated with a similar composition. The rice enters at the top and, falling down between the revolving cone and the casing, is subjected to an abrasive action which removes the last particles of husk. Finally, the clean rice is passed into polishers, which also consist of revolving cones surrounded by a casing lined with sheep skins with the wool on. The rice in its passage down the cone is polished by the wool. The dust is again removed by screens from which the finished rice tails over to be packed in bags for export.

Four thousand five hundred pounds of paddy yield on an average one thousand pounds of husk, and about 50 per cent. of No. 1 rice can usually be obtained from the paddy. The other products consist of rice meal and coodie of various grades.

To drive the mill in question, about 1,300 h. p. is normally required, and the steam is generated by burning the paddy husk in specially constructed furnaces, the products of combustion from which pass into the flues of the boilers. One pound of paddy husk makes about 2½ pounds of steam, and the paddy may be taken to be equal in calorific value to about one-third its weight of coal. In ordinary work, therefore, a rice mill yields very much larger quantities of paddy husk than can be consumed in the boilers generating the steam. The practice is to discharge the rest of the paddy husk into the river. The milling of boiled, or as it is technically known "parboiled", paddy has recently been introduced into Rangoon. Where this is done, the paddy is first steeped in water for a period of about 12 hours. It is then subjected for about half an hour to the action of steam in closed vessels. The paddy is then discharged and passed down a drying tower, up which currents of steam-heated air are forced. In India, where parboiled paddy is largely milled, it is usually manufactured on a small scale and the boiled or steamed paddy is dried on open floors in the sun. This is impracticable on a large scale, and artificial methods of drying it are employed in Rangoon. This increases the consumption of steam, and, where parboiled paddy is milled, it is said that there is now no surplus husk available.

The question of making some use of paddy husk has apparently engaged the attention of rice millers in Rangoon for some time past, and efforts have been made to create a market for the surplus husk, which is now discharged into the river. These have resulted in failure. Two difficulties confront any one attempting to make use of paddy husk as a fuel outside the rice mill. One is the extremely large bulk to be dealt with and the other the uncertainty of a regular supply. These difficulties should not be insuperable, provided the power stations are located on the river banks near the mills. Specially constructed barges should be able to transport the very large volumes to be dealt with, and the uncertainty of supply might be overcome by storage. Experience in Mysore, at any rate, shows that paddy husk can be stored in the open in very large heaps and that the rain only affect a thin layer on the surface. In the busy season, huge heaps of paddy husk

might be accumulated which would be available when the mills are not at work. This difficulty seems likely to be one of decreasing importance, as there is a marked tendency for the trade to cease to be a seasonal one and to be carried on throughout the year. This is due to the fact that godowns for storing paddy are now much more common up country than they used to be, with the result that a considerable proportion of the crop is held up after the harvest and not immediately sent down the river.

Although in the Rangoon rice mills the operations are carried out on a very large scale, the machinery is mostly of a very simple character, in some respects even primitive. Further, in the future it seems desirable that efforts should be made to utilise the various by-products more efficiently, especially the paddy husk.

These mills possess a fleet of over 200 rivercraft for the transport of paddy and between 20 and 30 lighters to carry the rice to the steamers moored in the Rangoon river. The risk of fire in a rice mill is very considerable, and the one we visited was burnt down about ten years ago.

The milling trade in Rangoon is of a very speculative character, as the mills purchase the paddy and sell rice while prices fluctuate very considerably. On the whole, large profits have been earned, but the number of mills now working is said to be greatly in excess of what is necessary to deal with the crop coming forward. Most mills are now shut down for a considerable part of the year; but it is doubtful if at any time they worked continuously, for, as has already been mentioned, the trade has now less of a seasonal character than formerly.

THE BURMA OIL COMPANY'S WORKS, SYRIAM.

Visited 25th January.

The oil is transported from the oil fields by a pipe line ten inches in diameter and 275 miles in length. The pipe line terminates on the right bank of the Pegu river, where a number of large receiving tanks have been erected. The main refining works of the Burma Oil Company are situated on the left bank of the same river, across which the oil is transported by another pipe line. The works cover a very large area and give employment to between 6,000 and 7,000 men. The daily flow in the main pipe line amounts to about 2,000 tons, involving a velocity in the pipe of about two feet per second. At present, only two pumping stations are required to maintain the requisite hydraulic gradient, and the delivery of the pipe line can, if necessary, be greatly increased by the addition of further pumping power. Apparently very little trouble is experienced from deposits forming on the inside of the pipes. The high temperature of Lower Burma has probably something to do with this freedom from pipe line troubles.

The processes carried on in the refinery are simple, but, on account of the large scale of operations, involve the use of somewhat complicated plant. By fractional distillation, the crude oil can be resolved into a number of commercial products, the most volatile of which is petrol with a specific gravity of 0·718 followed by motor spirit with a specific gravity of 0·750. Above the motor spirit, two grades of kerosene oil are extracted. Then follow a series of paraffins suitable for lubricating oils, paraffin wax and pitch. The residual oil, known as 'astatki', is a valuable fuel and, as such, is used to generate the very large quantities of steam required in the refining processes. It is also sold as liquid fuel and used in internal combustion engines of the Hornsby, Diesel and semi-Diesel types. One pound of oil in a good engine is capable of furnishing from 2 to 2·5 horse power hours.

The works have evidently grown up with the expanding output of the oil fields and, at the outbreak of war, the methods employed were distinctly inferior to those developed on the American and Galician oil fields. Of late, however, many improvements have been effected and, but for the difficulty in obtaining new plant and material, it is claimed that they would now be up to the standard of the most advanced practice elsewhere. The chief improvement

seems to be the fractionation of the oil by a continuous process instead of carrying it out in separate stages in separate buildings. The separation of the paraffin wax involves cooling the mother liquor to a low temperature and necessitates the installation of a large refrigerating plant. The refined paraffin wax is of a pure white colour and is sold as such or manufactured, with the addition of varying percentages of stearine, into candles; the capacity of the candle-making plant when in full swing, is about 600 tons a month. The percentage of stearine added to the paraffin wax for candle making varies from 3 to as much as 50 per cent.; but in the bulk of the candles manufactured, only a small percentage of stearine is used. Should it become necessary to produce glycerine on a large scale in India for military purposes by the Twitchell process, candle works will be able to take a considerable quantity of the stearine, whilst the balance will have to be employed as a basis for soap manufacture.

The subsidiary workshops necessary to carry on the work of refining include an engineer's shop, a large tin and drum-making plant and furnaces for revivifying the bauxite through which the oil products are filtered to decolorize them. Well away from the refining works are a very large number of 500,000 gallon storage tanks, in which the finished products can be held pending export. The petrol is apparently all sent away in tins and the kerosene oil largely in bulk. There are two laboratories, one for small scale work and the other for testing methods on a commercial scale; but the amount of original chemical work carried out by the officers of the company in this country appears to be comparatively limited. Apparently, the company relies mainly upon experts in Europe or America for the improvement or development of its methods of refining.

The evidence furnished to the Commission by Mr. H. L. Allan, the Works Manager, affords interesting and useful information regarding local problems connected with the training of the staff and the labour employed. The latter is almost entirely imported from India, and, as stated by Mr. Allan, the employés of the company remit to their relatives in India about half a lakh of rupees monthly. Barracks have been provided by the company for the accommodation of about 2,000 coolies, and the rest live in villages around.

THE BAWDWIN MINE.

Visited 28th and 29th January 1918.

The Bawdwin Mine is situated in the Northern Shan States about 100 miles to the north-east of Mandalay. The ore is carried by a two-foot gauge railway to Namtu where the smelting works have been established, and connection is obtained with the Burma Railways by a continuation of the line for 32 miles to Namyao on the Northern Shan States Branch about 180 miles from Mandalay.

The ore body in this mine consists of argentiferous galena and zinc sulphide with small quantities of arsenic, nickel, copper and antimony. The proportion of lead to zinc varies considerably: but the great bulk of the ore is unusually free from gangue. As far back as the 15th century, the existence of this valuable ore body was known to the Chinese, and it seems to have been worked either continuously or intermittently from that date till the outbreak of the Mahomedan rebellion in China in 1858. It is now reckoned that the Chinese must have removed at least half a million tons of ore from the mine, which they smelted in somewhat primitive furnaces with a view mainly of recovering the silver.

The recent work shows that the ore contains almost exactly as many ounces of silver per ton as the figure expressing the percentage of metallic lead; that is to say, there is about one ounce of silver to every 22 pounds of lead. The vast slag heaps left by the Chinese miners attracted attention, and modern work was started with a view to re-treat them as they still contained the bulk of the lead, but only a small percentage of the

original silver. This not very important mining venture led to the re-discovery of the ore bed which the Chinese had worked. The importance of the discovery was only gradually realised as the vast extent of the ore bed was proved.

At the lowest practicable level, a tunnel over two miles long has been driven. At a distance of over 7,000 feet from the portal, the ore is met with. Thence onwards, cross-cuts at frequent intervals have disclosed the width of the reef and the extent to which it is developed. This tunnel forms the sixth level in the mine, and above it there are five other levels at intervals of about 120 feet, the second being an enlargement of the old Chinese tunnel which penetrates the hill side about 500 feet above the sixth level. The ore body above the sixth level has now been completely explored and is estimated to contain over four million tons of workable ore. What exists below is a matter of conjecture; for as yet no exploratory work has been done. There is every reason to suppose that it continues to a great depth, and there is nothing improbable in the idea that only a comparatively small part of the actual ore body has been explored.

We were told that above £3,000,000 has already been expended in opening out this mine, which in 1915 produced 6,000 tons of lead, in 1916, 13,000 tons and in 1917, 17,000 tons, with the equivalent quantities of silver. The present scale of working is about 150 tons of ore per day, yielding approximately 50 tons of lead and 5,000 ounces of silver. No attempt has so far been made to recover the zinc, and only ore containing a high percentage of galena is now being treated. This is entirely due to the war. Ultimately it is proposed to develop operations to an output of 1,000 tons of ore per day and to recover both zinc and sulphur in addition to the present returns.

The chief obstacle to the rapid development of the mine is the inadequate provision for transport. The two-foot gauge railway from Namyao is very badly aligned, and the gradients are very steep. A metre gauge line is essential, and it is thought that it will be better to construct an entirely new line taking off from the Northern Shan States Railway at a point much nearer to Mandalay in the direction of Thebaw. The cost of working the mine is very greatly increased by its remote situation. Wood fuel is largely used, and 63,000 acres of reserve forests have been set apart to supply the mine. The present cost of wood delivered at the mine is said to be Rs. 14 per stack of, approximately, two tons. The consumption of fuel is very large and, as time goes on, the cost will be materially enhanced owing to the greater distance from which it will have to be transported. A bed of fairly good lignite has been discovered in the hills in the neighbourhood of Lashio; but the quantity available has not yet been ascertained. Crude oil from the Burma Oil Company is used to some extent in the refinery and in the electric generating station, where a 1,000 h. p. Diesel oil engine made by Sulzer Brothers has been installed. This has been at work for the last 18 months, and a second one is now being erected. For the blast furnaces coke is required, and it is imported from Bengal, costing as much as Rs. 70 a ton at the present time. The smelting of the ore requires the addition of nearly 50 per cent. of its weight of iron ore, and both hematite and limonite are used for this purpose. Part of this is obtained in the neighbouring hills and the balance is brought from a quarry near Mandalay. So far, no attempt has been made to utilise the valuable zinc ore; but this question can best be discussed later on after the smelting and refining operations have been described.

Besides the Diesel engines for generating power, quite a considerable number of steam plants are in use, worked with wood fuel. It has been found possible to establish a hydro-electric station a short distance away capable of providing about 2,500 h. p., and after prolonged negotiations, a satisfactory arrangement regarding the royalty has been arrived at, and the work will be taken in hand as soon as the necessary plant can be obtained. Explorations pushed to the borders of China revealed the possibility of obtaining something like 200,000 h. p., on the upper reaches of the Salwin river at a distance of about 60 miles from the mine. This is much more than could possibly be utilised for power purposes, and it is doubtful if electro-metallurgical processes

could be profitably employed. The ore actually in sight, if used at the rate of a thousand tons per day, will give the mine a life of about 12 years, and any extension of this period depends upon the quantity found to exist below the present lowest level. There is a reasonable probability of a life of 30 years; but this will be shortened if the rate of output is increased. Any big hydro-electric scheme is, therefore, hardly likely to be carried out unless prospecting work results in the discovery of other mineral deposits, the working of which will require a large amount of power.

The mine is situated in a sandstone hill into which the intrusive mass of rhyolite has penetrated. There are three lodes which, at the level of the tunnel, are about 1,800 feet in length and average from 50 to nearly 70 feet in width. The dip in the lower levels is vertical. The present method of working necessitates an enormous amount of timber, and it is now proposed to adopt a system devised in America within the last 4 or 5 years, whereby the use of timber will be to a large extent avoided and the voids formed by the removal of the ore will be filled with country rock. The method in practice seems to be extremely simple, but it is difficult to describe without diagrams.

The smelting works are situated on the Namtu river, near the village of Namtu. At present, the ore is only treated to recover the lead and silver. On arrival from the mine, the ore is first crushed and then put through a tube mill, after which it is mixed with about one-third of its weight of iron ore. It is then roasted on a horizontal revolving plate to reduce the sulphur contents from about 16 to 10 per cent. The revolving plates consist of a large number of circular furrows in which the ore rests. From the centre of the plate to the periphery, an arm extends, carrying as many rabbles as there are furrows, and these rabbles work the ore from furrow to furrow. The ore is fed in at the centre and gradually works its way to the periphery where it is drawn off. It is then carried to tilting pots, mixed with a little fuel and fired with an air blast, whereby the sulphur content is reduced to about 4 per cent. As soon as the operation is complete, the ore is tilted out and carried to the mixing platform where it is made up into charges for the blast furnaces. The exact nature of each charge depends upon the results of the assays. To the roasted ore is added limestone, a further quantity of iron ore and coke, the weight of coke required being about 14 per cent. of the charge. The blast furnaces are rectangular and 22 feet high. The blast is supplied at a pressure of from 30 to 35 ounces, and at intervals the slag and lead are drawn off. The slag is very fluid and contains from 12 to 14 per cent. of zinc or, roughly, 18 to 21 per cent. of zinc sulphide. The lead is drawn off and cast into pigs, the average composition of which is—

Lead	97 per cent.	
Copper	0·8	„
Antimony	1·0	„
Zinc	0·3	„
Nickel	0·6	„ and
Silver	about 100 ounces to the ton.	

The recovery at present amounts to about 72 per cent. and is, therefore, very far from efficient. The losses are chiefly due to volatilisation, which could be greatly decreased by the provision of depositing flumes and by the adoption of one or other of the well-known processes for recovering the dust. One of these processes involves the construction of a depositing chamber, in which the velocity of the gases is reduced from about 17 feet per second to about 3 feet per second and the air is filtered through a suitable medium, the necessary suction being induced by a fan. The other process consists in passing the gases through vertical tubes in which are suspended wires charged with electricity at a very high pressure. This causes the dust to adhere to the wire, and from time to time the earthing of the wires causes the dust to drop off. It is understood that this latter process will be adopted. The loss of lead and zinc by volatilisation in the blast furnaces amounts to at least ten per cent. and is fairly serious. As already mentioned, the slag contains zinc sulphide to the extent of about 20 per cent., the treatment of which at Namtu, to recover the zinc, is considered impracticable.

A proposal is under consideration to transport the slag to the neighbourhood of Sakchi and there to erect zinc smelting works, recovering the sulphur in the form of sulphuric acid. It is at least open to consideration whether it would not be advisable to transport all the ore in this way and to carry out the complete smelting operations in India. Against this proposal is (1) that the existing smelting works and refinery would have to be scrapped; (2) that galena only contains about 14 per cent. of sulphur whilst the zinc sulphide contains 33 per cent. On the other hand, by the use of concentrators and separators, the ore could be sent away from the mine in a state of great purity, and the total transport charges would probably not be greater than they are now, whilst the general operating charges would be much lower on account of the cheaper labour and smaller cost of fuel. The Burma Mines Company, however, seem to have definitely committed themselves to the production of lead at Namtu and to the proposal to smelt the zinc ore in the neighbourhood of Sakchi.

For the development of this scheme, it is necessary to separate the galena and zinc sulphide as far as possible, and an experimental plant on a considerable scale is now in operation at Namtu with, what are said to be, favourable results. The ore is ground very fine and the first separation is effected in gravity separators, the tailings from which, consisting chiefly of zinc ore with some galena, are subjected to a further treatment by what is known as the floatation process. The result is that two grades of ore are obtained, one containing nearly all the lead and the other nearly all the zinc. This zinc ore would be sent by rail to Rangoon and thence by sea to a convenient port in communication with Sakchi.

The Bawdwin Mine is a unique occurrence in the Indian Empire, and it is desirable that its ore should be so worked that the whole mineral value is obtained. In the early days, the Chinese worked the mine for the sake of its silver. It is now being run for the sake of the lead in addition to the silver, and, under war conditions, this may be justifiable. So far, the zinc and sulphur have not been utilised, and it is doubtful if they can be profitably handled in the neighbourhood of the mine in present circumstances. The sulphur can only be recovered in the form of sulphuric acid, and for the smelting of the zinc large quantities of imported fuel will be required. It is, therefore, obvious that the Sakchi scheme is the correct solution of the metallurgical problem, though whether the zinc works should be erected at Sakchi or on the sea coast in Bengal, depends upon the relative costs of assembling the raw materials and disposing of the finished products at the alternative sites.

The refining processes.

The hard lead from the blast furnace is first re-melted in what is known as an improving furnace, which is merely a reverberatory hearth capable of holding about 100 tons of lead. The lead is only just melted, and the dross which forms on the surface carries with it most of the copper, nickel, arsenic and some of the silver. The purified lead is then run into another furnace of smaller construction but worked at a higher temperature, and distinguished as the antimony furnace. Here the dross removed is termed the antimonial skimmings, which consist mainly of oxides of lead and antimony. The dross from the improving furnace, and the dross from the antimony furnace, when sufficient quantities have accumulated, are charged into a residue furnace together with coke fines and a little galena. The resulting products are hard lead, which is run back into the improving furnace, a copper mat, consisting mainly of sulphide of copper and lead, nickel speiss and antimonial slag. The antimonial slag can be treated by itself in a blast furnace, resulting in the production of refined antimonial lead suitable for munitions and type metal. Returning to the antimony furnace, the lead produced in the same is soft and contains only a small quantity of copper and antimony, together with the bulk of the original silver. This lead is run into large kettles and about two per cent of zinc is added and well stirred in. The resulting crust, consisting of the mixture of lead, zinc and silver, is scraped off and subjected to pressure in what is known as a Howard

press, whereby the bulk of the lead is squeezed out, leaving an enriched silver crust consisting mainly of silver, lead and zinc. It will be here convenient to follow the silver refining. This silver crust is put into graphite retorts and strongly heated in an oil-gas furnace. The zinc distills over and is condensed for use in the kettle again, whilst the lead remaining behind is removed to the concentrating cupels which are also oil-heated. The lead is worked off as litharge which goes back into the blast furnace, and silver 995 fine is produced. This is further refined in a second cupel and cast into bars weighing about 1,125 ounces each. Returning to the kettle, underneath the silver crust is the silver-free lead, containing a little antimony and about 0·6 per cent. of zinc. This goes into a second kettle, known as the merchant kettle, which produces fine lead and a surface dross containing the oxides of antimony and zinc mixed with litharge. The temperature of the merchant kettle is necessarily very high, and the dross formed is transferred to the blast furnace. The final products of the refinery are lead, containing a few thousandths per cent. of impurities and silver up to 998 fine. The re-treatment of some of the by-products in blast furnaces produces antimonial lead, which may be regarded as a final product. The copper matte and the nickel speiss occur in relatively small quantities but are important, since the scale of operations is large, and these require separate treatment. So far, the quantities produced have not been sufficient to call for any special arrangements to realise their potential value. The losses in the refinery have not been ascertained; but they are obviously very much smaller than in the smelting houses. There is no doubt the processes employed are efficient, as the quality of the products testify; but the *kutcha* arrangement of the plant will at least justify the assumption that, in regard to labour and fuel, the charges are probably high. The Bawdwin mine is so situated that the provision of adequate fuel will always be a source of anxiety, and it is therefore necessary that economical working should be deemed a matter of primary importance. It is possible that the lignite which has been discovered in the neighbourhood of Lashio may improve matters very much, as the lignite can be readily gasified and the gas used for practically every operation except in the blast furnaces.

There is a very large staff employed on the mine, the superior members of which are mainly Americans. Coolies number between 7,000 and 8,000 and are largely Maingtha Shans; but there are also a large number of Chinese from across the border. Indians from the Madras ports on the east coast only number a few hundreds, and of Burmese coolies there are scarcely any. A conspicuous feature of the mine is the excellent provision for housing the labour employed. The superior staff have excellent bungalows, and the quarters provided for the coolies are probably considerably beyond their own ideas as to what is necessary. The superior staff includes one educated Indian and three educated Chinamen. The conditions at present render this mining camp an almost ideal place for intelligent and hard working students of mining and metallurgy. The first stage has been passed through, and the mine is thoroughly well established; but everything is in the transitional stage between development and realisation. Exploratory work and experimental work up to a certain stage have been completed, and it is possible to calculate fairly accurately what the future returns are likely to be and to come to a definite conclusion regarding the scale of operations. The period of reconstruction affords considerable opportunities for gaining experience; but it does not appear that any attempt has been made to utilise them for the benefit of the people of Burma or of India.

THE IRRAWADDY MATCH COMPANY, MANDALAY.

Visited 31st January, 1918.

The representative of the proprietors of this factory informed the Commission that it was started some five years ago, largely in consequence of the recommendations contained in the official bulletin of the Forest Department regarding wood for matches. The factory is unusually well-equipped and is

on a sufficiently large scale to justify the employment of a capable and well-paid manager. The bulk of the machinery is of German origin and was supplied by the makers specially to deal with the wood used in the factory, namely *bombax malabaricum*. Apparently, the guaranteed output has never been reached; but this has not been a source of serious trouble as the factory has always been capable of a larger output than was absorbed by the market available to it. In this instance, there has been no lack of capital either for the plant to start with or for subsequent working. We were told that in all about eight lakhs of rupees had been expended; that, from the beginning up till quite recently, the factory had worked at a loss and that, at the present time, a small profit was being earned, chiefly due to the steady rise in the price of matches. The company, however, will only be able to continue operations for a short time longer as their stock of essential materials is running out, and they are unable to obtain fresh supplies. These include phosphorus, sulphur, potassium chloride and paper for the boxes. There is an ample supply of *bombax malabaricum* which is delivered at the factory in suitable sizes and in excellent condition at Rs. 10 a ton.

The mechanical equipment of the factory is good, and there appears to have been no lack of technical skill in directing it. The matches turned out are as good as is possible to make from the wood available, and their main defect is their reddish colour. There is no doubt that at least average business ability and sufficient capital have been available and that the want of success of this factory is not due to the ordinary causes which have been responsible for so many failures of this kind. For the present and so long as the war continues, there is no doubt that, if the materials already mentioned were available, the factory would be able to compete with the Japanese matches; but in ordinary times, they have not only been undersold, but there is no doubt that their products are not considered of equal quality. This is chiefly due to the dark colour which is not appreciated by the traders through whom the matches ultimately reach the consumers. Possibly, detailed investigation of the management of this factory would reveal weak spots; but they were not visible to the Commission in the course of their inspection nor were they disclosed during the examination of the manager.

The company has no outlet for its products outside Burma; but as it has hitherto been unable to stem the tide of Japanese matches flowing into the country, the limitations of its market do not explain the present situation, though attention may be drawn to the facts disclosed in the evidence regarding freights put in by Mr. Watson. From this, it would appear that, previous to the outbreak of war, the cost of sending matches from Japan to Rangoon was the same as from Mandalay to Rangoon, and that the cost of sending matches from Mandalay to Madras was three times the shipping charges from Japan. The strangling effect of heavy freight charges, especially on the part of the coasting steamers, is clearly evident, and special steps seem necessary to counter the policy of other countries, who have unquestionably been able to establish themselves in Indian markets solely by reason of the enlightened shipping policy which has been enforced by their respective Governments.

It seems desirable that some special effort should be made to keep this factory going. The amount of material required is trifling, and a recommendation in its favour might be made by the Commission to the Indian Munitions Board. A little assistance in this way would keep the factory going, and the owners seem to think that they are entitled to ask for such assistance, as they started the factory on official recommendations which, subsequent experience has proved, were not altogether warranted.

SAUNDERS WEAVING INSTITUTE, AMARAPURA.

Visited 1st February, 1918.

The origin of this Institute is described by Mr. L. H. Saunders in the evidence which he submitted to the Commission. At the time of the annexation of Upper Burma, hand-loom weaving was a home industry and the clothes

worn by the people were entirely of local origin. The opening up of the country brought in the woven goods of Manchester and Japan and gradually ousted the domestic weaver. It is not quite clear with what objects this Institute has been founded. Vaguely, it is to keep hand-loom weaving going by introducing the hand-loom weaver to modern methods and appliances. The witnesses who have come before us stated that the Institute is a success: but when asked to specify in detail what results have been achieved, refer to the unfortunate conditions prevalent amongst the weavers consequent upon the war and the rise in prices. The Institute, as it is at present constituted, is under the administrative control of the Registrar of Co-operative Societies. The superintendent was trained in the Victoria Jubilee Technical Institute in Bombay, and has had a subsequent miscellaneous experience with private firms, the Salvation Army and the Serampore Weaving School, in which institution he was for some time the assistant superintendent. The superintendent has now been in charge of the work for four years and has introduced into the Institute the Hattersley loom and the Salvation Army fly-shuttle loom. The pupils who come to the Institute, receiving a Government scholarship of Rs. 15 a month, are put through a course of instruction lasting six months. At the time of our visit, the majority of the pupils were young women. Mr. Clayton, the Registrar of Co-operative Societies, privately informed us that the past pupils from the Institute make no use of the course of training they have received. This is at variance with the evidence submitted by the superintendent who furnished a list of between 40 and 50 Salvation Army looms and about a dozen Hattersley looms which had been placed in the neighbourhood. The two statements may easily be made to agree on the assumption that, although the looms have been purchased, they are not worked. This has certainly occurred in parts of India and might well occur in Burma, when it is desired to declare that a certain course has been a success.

It is difficult to get at the results so far accomplished, and no financial statements of any kind have been furnished to us. There is no doubt that a good deal of money has been spent on the Institute, and, it is almost certain, without any adequate return. It is, however, not necessary to scrutinise the financial position very closely. Some very pretty weaving, so far as colour and material are concerned, is done in the Institute, and the general effect on entering the weaving shed is pleasing. The actual weaving is bad, and this may be attributed to an unfortunate choice in the type of loom. The Institute has done nothing so far, and it is likely to end in a ghastly failure, though it is possible, with some change in the methods and policy, it might become a brilliant success. What actually seems to be wanted in Amarapura at the present time is a weaving shed pioneering modern methods of silk weaving. Force of circumstances seems to be driving the Institute in that direction as they are now taking orders for goods and trying to get them made. It would be better frankly to endeavour to work on commercial lines. The object should not be to give a short course of instruction to as many weavers as possible, but to train up a certain number to become thoroughly proficient in the use of modern hand-weaving appliances. Most of the weavers are apparently young women, and it is futile to imagine that an imperfect course of instruction in fly-shuttle hand-loom weaving is going to do anything to keep the domestic industry alive. The conditions seem favourable for the establishment of hand-loom weaving factories in which most of the employés would be women. Such a factory would be impossible in India, but presents no difficulties from a social point of view in Burma. It would be a legitimate operation for Government to establish such a factory or to convert the Saunders Weaving Institute into such a factory.

In many respects the superintendent seems to possess the necessary qualifications to run the Institue. The work with the Hattersley loom should be abandoned. It has never been a success in India, and no other result is likely to be obtained in Burma. The Hattersley loom is essentially a power loom, modified and lightened in its various parts so that it can be driven by pedals. To obtain the best results from the power loom, it is necessary that it should be driven at as nearly uniform a speed as can be obtained, and the various parts of the loom are designed to work at that speed. The success of

electric driving in modern weaving sheds is largely due, not to the economies effected in the transmission of power, but to the improvement in the weaving consequent upon the more uniform rate of working. To give a power mill to a hand-loom weaver and ask him to drive it, whether by means of pedals or by turning a handle, is to convert him into a machine tender who has unfortunately to supply the motive power to drive the machine. Obviously, it will be impossible for him to maintain a regular rate of working, and the production of the loom will suffer accordingly. That this is so has been discovered in India, and the Hattersley looms have been scrapped.

With regard to the Salvation Army loom, it has also been found to be a failure in India, although it has been boomed with all the skill and experience which that organisation possesses. It is fundamentally wrong in principle to attempt to supply the power to drive a loom through the slay which is used to beat up the weft. Yet, this is done in the Salvation Army loom, with the result that the weaving is always poor with warp threads frequently broken. The backward motion of the slay in the hand loom should be as gentle as possible; but this operation has to be violently performed in the Salvation Army slay as it is used to operate the mechanism which drives the shuttles. Experience in India has shown conclusively that the old English fly-shuttle slay has not been improved upon by any of the fancy mechanisms introduced into India in the last 10 or 15 years. They all suffer from the defect that they are attempts to compromise between manual and machine methods of working. At Amarapura, it would perhaps be advisable to scrap the Salvation Army mechanism and fit all the looms with English fly-shuttle slays. This would not cost much. The Hattersley looms should be put on the scrap heap. It was stated to us that the local weavers much preferred the Salvation Army slay to the English pattern, and no doubt this is true; but they have not adopted it, and there is no reason why they should be allowed to do so. In our opinion, it is the business of the Institute to teach the weavers what is best, and not to allow them to adopt an apparently facile, but exceedingly imperfect, method of working.

This Institute furnishes an excellent example of the necessity for some kind of imperial organisation to co-ordinate work in various parts of the Indian Empire. Working along certain lines, good progress has been made in Madras and Bombay; working on different lines, apparently nothing has been accomplished in Bengal, and now it appears to us an attempt is being made to introduce into Burma what has so signally failed in Bengal.

THE BURMA OIL FIELDS.

Visited 3rd and 4th February 1918.

Of the various oil fields which have been discovered in the Irrawaddy basin, the Commission visited those at Singu and Yenangyaung. Earth oil was known to the Burmans before the occupation of the country, and the superficial deposits were worked by them through deep rectangular wooden shafts which they sunk with considerable ingenuity and much labour. The largest development of oil occurs in the Yenangyaung field, where a number of companies are working and where about 1,000 wells have been sunk. Roughly, two-thirds of these belong to the Burma Oil Company; and the remainder to three other companies: (1) The British Burma Petroleum Company; (2) The Indo-Burma Petroleum Company; (3) The Nathsingh Oil Company, besides a few private owners, including some of the original Twinzas, who still continue to sink shafts and work their oil claims by the old indigenous methods.

The mining rules prescribe that each well should have a minimum radius of 60 feet round it from which to draw oil, and wells should not, therefore, be sunk within 120 feet of one another. The result of divided ownership on the Yenangyaung oil field is a dense forest of derricks, an apparently inextricable network of pipes, an unnecessary number of storage tanks, several water supply schemes, and bullock carts and primitive methods of transport

working alongside the well-ordered aerial ropeway of the Burma Oil Company. This is due to the fact that originally the field was held by Burmans, known as Twinzas, who have disposed of their rights to the companies which have been formed, and which were allowed to purchase them without regard to any other considerations than surface ownerships. It seems extraordinary that no attempt has been made to consolidate the various interests working on this field, as the economies which could be effected would be remarkable. Doubtless, the matter has been considered, and it will certainly have to be considered again, if the oil field is to be worked to the best advantage, when the supplies have to be drawn from the deeper sands. Apart from the old Twinzas workings, the methods developed on American oil fields are employed in Burma and all the drilling is done by Americans. At Singu, the number of interests on the field is not so large and there is no mixing up of claims, so that the wells are sunk at a reasonable distance apart.

The yield of the Burma oil fields is roughly 20,000 barrels a day, each barrel being equal to 42 U. S. gallons. Of this, roughly, one-fourth comes from Singu and the balance from Yenangyaung, the yield of the other fields at present being comparatively small. The Burma Oil Company have laid a pipe line from Yenangyaung to Rangoon, a distance of 275 miles, and the bulk of the oil that they raise is delivered to the Rangoon refineries in this way. The oil is forced through the pipe by two pumping stations, the first at Yenangyaung, which was inspected by the Commission, and the second about half way down the line. The carrying capacity of the oil pipe of course depends upon the hydraulic gradient maintained and as this at present is a very flat one, the deliveries through the pipe could be greatly increased by the provision of further pumping stations. The wells yield considerable quantities of gas, some of which is drawn off and burnt under the boilers which generate steam for the pumping plants.

At Yenangyaung, there is a large pumping, plant to force the oil into the delivery main, a small pumping plant to raise water from the river to a settling tank, and a large steam pumping plant to pump this water to the oil field which is at a distance of some five miles. Liquid fuel is burnt under the boilers, and this is not obtained from the Yenangyaung oil field, but from one lower down the river at Minbu, where the crude oil contains less benzine than at Yenangyaung and is therefore safer to handle, besides being bulk for bulk less valuable.

But few of the wells yield oil without pumping, and the majority of the pumps are worked with small steam engines supplied with steam from central batteries of boilers. The steam pipes are long, the amount of condensation must be great, and generally the system is extremely inefficient. At a few of the wells, small oil engines are employed to drive the pumps and such engines are satisfactory for pumping, but they are not convenient for drilling. A well is not sunk to its full depth at once but at intervals the depth is increased, as one layer of oil bearing sand after another is exhausted. Moreover, from time to time, the wells require to be cleaned, so that it is necessary to be able to work the well-boring tools at any moment, and it is therefore convenient to have a steam engine permanently installed. Obviously, the most economical way of working the field would be through a central electric generating station and this, we understand, has been under consideration for some time past, but has been delayed owing to the war. It is difficult to understand why it was not started long before the war.

Most of the machinery employed on the oil field is of British manufacture; but the boring tools and lining pipes are usually of American origin. As already mentioned, the drillers come from the United States, some from the Pensylvania oil fields and some from the Californian, and it is said that there is a healthy rivalry between the men from the two fields. Some Burmese drillers are now employed with good results by one of the companies. The American drillers, on piece-work, earn as much as Rs. 900 a month. The work requires very great experience and the exercise of constant care. The drilling work at Yenangyaung is said to be easy compared with that on American oil fields.

Yenangyaung is a flourishing little town which will only last as long as the oil supply. The labour on the field is well housed: but from time to time there has been serious trouble not only with the durwans but also with the drillers. This is due to the employés having over-estimated the value of their local experience, and the failure of their attempts to force the hands of the companies will probably prevent a recurrence of similar trouble.

For the maintenance of law and order and to ensure the observance of mining rules, the civil administration is entrusted to a Warden of the oil fields, and, so far as the Commission could learn, the arrangement has proved a satisfactory one.

THE JAMAL COTTON AND PRODUCE COMPANY, ALLANMYO.

Visited 5th February 1918.

Allanmyo, on the left bank of the Irrawaddy near the southern edge of the dry zone, is favourably situated for dealing with such produce as cotton and oil seeds. The company is a private concern, the joint property of Messrs. Jamal Brothers and Messrs. Steel Brothers, and it is managed by the latter firm. The produce dealt with consists of cotton and groundnuts.

There is a ginning factory equipped with 60 gins, 40 of which were working at the time of our visit. The arrangement of machinery and plant is of the usual type, two long rows of gins driven from a central shaft in the basement. The ginned cotton passes to a baling press, and the bulk of the seed to an oil mill. The baling press is of the usual type and in the busy season about 100 bales a day are turned out. It may here be interesting to note that the baling hoops were of shell discard steel which, in this instance at any rate, has been found to be perfectly satisfactory.

The cotton-seed oil mill was furnished by Messrs. Rose, Downs and Thompson of Hull, with some American machines of a special type. The cotton seed is not delinted and passes direct to a decorticator and thence to a separator, where the hulls are removed from the kernels. A second sieve completes the separation of the husk, and the clean seed is crushed between rollers and then ground under edge runners into a fine meal. The fine meal is heated in a steam-jacketted kettle and packed in camelhair cloths for the oil presses. Of these oil presses there are four, and the outturn of oil was said to be 1,600 viss or about 5,000 pounds per day. The yield of oil from the cotton seed averages ten per cent. The oil from the presses is filtered and passed into the refinery, where it is heated with live steam and treated with caustic soda, after which compressed air is blown through it. The operation is repeated, and the oil then comes into the tanks to settle. At Allanmyo, about 80 per cent. of refined oil is obtained. This is sold locally in Burma, and a market has recently been found for it in Australia. The residue from the refined oil, known as "foots," is sold in Rangoon for the manufacture of cheap soap. In another factory at Myingyan, near Mandalay, the refining process is said to result in a loss of only 5 per cent., which is due to the skill of the foreman in charge of the work.

There is also a groundnut oil mill, consisting of eight presses, also supplied by Messrs. Rose, Downs and Thompson of Hull. This mill is capable of dealing with about 50 tons of undecorticated groundnuts per day. Although there are decorticating machines in the factory, they were not at work. The nuts are broken up in a disintegrator, passed through rollers and steam heated. The oil from the presses when filtered is ready for the market. No very accurate figures could be obtained regarding the results. The yield of oil was said to be about 30 per cent of the gross weight of the nuts. The oil is usually exported; but there has been difficulty lately on account of the want of freight. Both the cotton-seed oil and the groundnut oil are packed in forty-pound tins, and there is a complete plant of tin-making machinery installed in a separate building. This plant is capable of turning from 600 to 1,000 tons a day, and all the soldering is done by hand.

At the present time, the manager of the factory is a Mahomedan, and the mechanical engineer in charge of the machinery is an ex-student of the Victoria Jubilee Technical Institute in Bombay who is paid Rs. 275 a month. What seems to be extensive godown accommodation has been provided and the whole place is kept in admirable order. Perhaps the most striking feature in the management was the fact that there is no chemist on the staff, and that no effort is made to compare the results obtained in the mill with the actual oil-content of the seed as determined by analysis.

An examination of the cotton before ginning, revealed a variety of species, some of which were of much finer quality than others. Obviously, there is no pure strain of cotton seed in Burma, and attempts to improve the yield of cotton on lines similar to those which have proved successful in India might well be attempted.

The oil cake from the mills was formerly exported; but now no other use can be found for it than as fuel, for which purpose it is now worth about Rs. 10 per ton. This is a purely war time necessity; but that oil cakes, excellent both for cattle feeding and manure, should have to be so disposed of, indicates the primitive state of agriculture and the need for improvement.

HAND-LOOM WEAVING AT SHWEDAUNG.

Visited 6th February 1918.

Hand-loom weaving in Burma is a domestic rather than a cottage industry and is chiefly carried on by women. To obtain some criterion by which to estimate the value of the work done at the Saunders Weaving Institute, Amarapura, a visit was paid to the weaving town of Shwedaung which is situated on the Irrawaddy river, some eight miles below Prome. A considerable number of weavers' houses were visited, and in all of them it was found that the work was mainly carried on by women in such intervals of leisure as they enjoyed from their domestic occupations. The looms employed are of the simple frame type. Most of the slays were fitted with brass reeds but the shuttle was invariably passed through the warp by hand. Nearly all the work was in silk, the width of the cloth woven being about 22 inches. No warping was seen, but we were told that this was usually done in the streets in the way ordinarily followed in India. All the weavers' houses were framed structures raised on wooden columns 8 to 10 feet above the ground, and the looms were almost invariably placed in the open space under the houses. In some houses, there were two, and in others three looms; but in the majority of cases, there was only a single loom. A great many weavers possess a very well made silk-twisting machine of a pattern which it is claimed was invented locally; but it is far more likely that it is of European origin.

The conclusions arrived at regarding the work at Amarapura are completely substantiated by the inspection of the weaving in this town, and it is desirable that the Saunders Weaving Institute should be organised with a view to demonstrating the superiority of the innovations in weaving methods which it is seeking to introduce. The bulk of the weaving at Shwedaung was of much better quality than could be produced on the looms employed at Amarapura. The average weaving, however, is distinctly inferior to what would be found in a weaving centre of similar size in India.

We have been authoritatively informed that both silk and cotton weaving are rapidly declining in Burma, and this must be due to the competition of either cheaper or better made imported goods. It is probable that Burmese taste is changing and that, if the domestic industry is to survive, the technique of the weavers must be improved. At Amarapura, it would seem that this point has been entirely neglected and that attention has been concentrated on increased speed of weaving. It is interesting to note that a Hattersley loom, with a revolving shuttle box, was found in one of the weavers' houses at Shwedaung. The owner stated that he had purchased it four years ago and had paid Rs. 400 for it; also that he had worked it at the beginning but that, as he was unable to find any one capable of working it for him, it had not been used since.

The silk-weaving industry in Burma seems to be entirely confined to plain weaving, and variety and ornament are solely due to the use of different coloured threads in the warp and weft, that is to say, everything is of a chequered or tartan pattern. Dobbies and jacquards are unknown, and nothing so complicated as a solid border cloth is attempted in Burma. The industry is a very primitive one, and it is not so much a question of resuscitating an old industry as of creating a new one that has to be faced, and the chief reason for doing this is the fact that it would probably keep in employment a very large number of women who are now being gradually ousted from a very suitable domestic occupation.

THE GOVERNMENT SCHOOL OF ENGINEERING AND TECHNICAL HIGH SCHOOL, INSEIN.

Visited 7th February 1918.

This School is under the Director of Public Instruction advised by a visiting committee. It is situated on the Mingaladon road, about a mile and half to the north of Insein railway station. The buildings include a main school building, workshops, a hostel for students and quarters for some of the staff. The School is a large two-storeyed building containing class rooms, laboratories and offices. The chemical and physical laboratories are very imperfectly equipped, the latter being chiefly supplied with relics from Cooper's Hill. The mechanical laboratories are not much better, though there are some machines which can be employed for simple engineering testing. On the other hand, the workshops are distinctly good though not large. There is a carpenter's shop, a smithy with six hearths and a fitting shop. The machine shops are very badly arranged but contain a number of excellent tools and an unnecessarily large steam engine, probably installed with the idea of making steam tests. Just outside the workshop, there is an artesian well 240 feet deep and, adjacent to it, a water tower and a long trough for testing and calibrating current meters. The current meters are suspended from a carriage travelling over the trough and are controlled electrically. The hostel has accommodation for about 80 students and is constructed on the dormitory system.

The courses of instruction provided are somewhat complicated and are probably an attempt to suit the peculiar conditions which prevail in Burma. The Technical High School admits students who have passed the 7th standard in the Anglo-vernacular schools or the European Middle School examination, whilst the qualification for admittance into the School of Engineering, is the High School Final or the Calcutta Matriculation. Primarily, the Technical High School provides a training for sub-overseers in the Public Works Department, whilst the Engineering School aims at a higher standard, such as is demanded from overseers. In each case, the course of instruction is three years; but the students of the third year in the Technical High School can take a fourth year with the third year students of the Engineering School, and thus qualify for upper subordinate service. Besides providing a training for civil engineers, special arrangements are also made for the training of mechanical and electrical engineers. The first differentiation takes place in the second year when mechanical engineering is taught instead of civil engineering and in the third year, a distinction is made between the courses of instruction for mechanical and electrical engineers. Finally, at the end of the third year, the students are drafted into workshops for a two years' apprenticeship. It is also possible for the students in the Engineering School on the civil side to take up architecture for the third year; but it is not quite certain that any of them have availed themselves of the privilege.

The feature which distinguishes this School from any others visited by the Commission, is the attempt that has been made to work on what may be termed a 'sandwich' system. Half the time of the students is devoted to practical work under shop conditions and the other half to technical studies in the School itself. The civil engineering courses begin on the 15th of June of each year and terminate in December. The first three months of the year

are spent out in the field on survey work, and the School is only used for working out the results obtained in the field. At the end of March the long vacation commences, and the students are drafted for two months in the Public Works Department for practical training. In the mechanical engineering classes, the students study in school from the middle of June to the end of December, and are then drafted into selected shops for practical training from January till the end of May. This system of education is by some people considered to be ideal and is to some extent in vogue in Scotland and possibly on a larger scale in America. On the whole, the results obtained with it are disappointing and this, in the opinion of the Principal, is what has happened in Burma. The lack of continuity is fatal to the School work. The more highly educated and the more intelligent the students, the better are likely to be the results of the 'sandwich' system, as the evils arising from lack of continuity in the courses of study are less marked. Workshop instruction appears to be of a practical character due to the experience of the technical instructor.

There is, in addition to the classes already mentioned, provision for the instruction of apprentices who are to be trained as craftsmen. The educational standard insisted upon is the 5th vernacular, and the boys are apprenticed for a period of five years, during which time, they are paid wages at the rate of Rs. 12 for the first year, increasing by annual increments of Rs. 1-8-0 to Rs. 18 for the fifth year. Each apprentice gets a short course of instruction in carpentry, then in fitting and finally in blacksmith's work. At that trade at which he shows the greatest aptitude, he is required to spend the rest of his time. Apparently, the aptitude for different trades varies considerably, and it is claimed that the short preliminary general course prevents a good many attempts to drive square pegs into round holes.

The relations between the school authorities and the large employers of labour in Rangoon seem to be excellent and, without discounting the personal element involved, this may to some extent be due to a recognition on the part of the employers of labour, including the Public Works Department, of the necessity for assisting educational efforts in every possible way. The dependence of Burma upon India to the extent that is now necessary is generally regarded as undesirable, and there is a strong demand for increased educational facilities in Rangoon.

Some of the members of the Burma Advisory Committee expressed to us the opinion that the location of the Engineering School at Insein was a mistake and that it would be better to transfer it to Rangoon. On this point, it is difficult, without more local knowledge, to express a decided opinion. In many respects Insein seems to be quite satisfactory, as the workshops of the Burma Railways are situated in the town and there is an excellent service of trains into Rangoon.

CALCUTTA TECHNICAL EVENING SCHOOL.

Visited 28th February 1918.

This School was established in November 1900 to supply elementary technical instruction to the apprentices engaged in the large engineering works in Calcutta and Howrah. Its inception was due to the engineers of the East Indian Railway; but, throughout its career, it has been warmly supported by the private firms of Calcutta and by the technical officers in charge of Government undertakings and such public bodies as the Port Commissioners. The School was first started in Howrah; but in less than two years it was found desirable to transfer it to Calcutta, as the majority of the pupils lived on that side of the river, and rooms were obtained in the Doveton College, where the School was maintained till the College was dismantled in 1909. For six years, it was then located in the upper class rooms of the St. Joseph's School, Bow Bazar. In May 1915, it was transferred to the Free School and finally, in November 1917, to a set of rooms on the ground floor of the School of Art in Chowringhee.

The boys who attend the School pay a fee of Rs. 5 a month for all or any one of the following classes: (1) Elementary Mathematics; (2) Practical Mathematics and Mensuration; (3) Pure and Applied Mechanics; (4) Elementary Magnetism and Electricity; (5) Advanced Magnetism and Electricity; (6) Building Construction and Materials; (7) Theory of structures and Strength of Materials; (8) Steam and other Heat Engines; (9) Mechanical Drawing. The classes are held on three nights in a week from 5-30 to 7 P.M., and, at the present time, we were informed that there were about 110 paying students on the books of the school. The fee-income amounts to something over Rs. 5,000 a year, in addition to which the following grants are made:—

	Rs.
Government	2,000
The East Indian Railway Company	600
Messrs. Burn & Co., Ltd.	750
Messrs. Jessop & Co., Ltd.	250
Messrs. John King & Co.	250

The Principal is Mr. J. R. Wylde of the East Indian Railway who is paid Rs. 150 a month and is assisted by a staff of five officers from the various engineering works, whose apprentices attend the School. These officers are remunerated at the rate of Rs. 10 for each evening's work. At the time of our visit, we saw the following classes undergoing instruction:—

Practical Mathematics and Mensuration.
Applied Mechanics.
Advanced Magnetism and Electricity.
Mechanical Drawing.

The work was naturally of an extremely elementary character except in the case of the electrical class; but there is no doubt that the instruction was practical and suited to the capacity of the students. So far as the class rooms provided in the School of Art are concerned, the accommodation was good, but the rooms are only in the occupation of the School after 5 o'clock in the evening, and there is an entire absence of space for anything in the nature of practical demonstrations. The records of the School show that a number of the apprentices have done well in after life; but the committee of management recognise that the resources at their disposal are altogether too limited to provide the training which it is desirable the apprentices should receive. Considering the enormous importance of the engineering industries in Calcutta and its neighbourhood, it is surprising that the technical instruction of the apprentices and workmen employed should be entirely left to private enterprise. The excellent work done in this school justifies the assumption that, if greater facilities were offered, its sphere of usefulness would greatly extend. The fact that after 17 years of useful work this technical school should still be without premises of its own and dependent upon another Government educational institution for its accommodation, is an illustration of the inadequate attention paid to technical instruction in Calcutta. There seems to be but little doubt about the urgent necessity for providing greater facilities for the training of the youths in Calcutta employed not only in the large engineering works but in the very numerous smaller concerns which have grown up in recent years. Something analogous to one of the London polytechnics seems to be clearly indicated. In view of the fact that only evening classes are required, it seems open to discussion whether it will not be possible to establish a high-grade practical secondary school which should occupy the premises in the day time and leave them free for the work of the technical school in the evening. This double use of the premises, which must be necessarily located on one of the main tram lines so as to afford the students easy means of getting to them, would justify very much larger initial expenditure than would otherwise be the case, and would enable much better provision to be made for both classes of students than would be possible if only one were under consideration.

THE EAST INDIAN RAILWAY LOCOMOTIVE WORKSHOPS, JAMALPUR.

Visited 11th March 1918.

The Locomotive Workshops of the East Indian Railway are situated at Jamalpur, 297 miles from Calcutta, and 6 miles from Monghyr. The Company possesses very nearly 1,300 engines, and 11,000 men are employed in the shops. There is a large European settlement at Jamalpur, and a considerable number of workmen live in the town which has grown up round the works. Large numbers, however, reside in neighbouring villages and in Monghyr, and special workmen's trains are run both morning and evening to bring the men into the works and take them home again.

The object of the visit to Jamalpur was to discuss on the spot the question of training various grades of employés in mechanical engineering establishments, and to examine the facilities, possessed by the company for such work. Something is already being done in this direction, which, both the officers of the company and the Commission think, it is now desirable to extend and improve.

It is only necessary to describe the works in very general terms, and in relation to the opportunities they offer to various grades of apprentices and mechanical engineers for acquiring up-to-date practical experience. These workshops were probably the first started in India for the repair of locomotives, and during the last 70 years they have been enlarged and developed, as the expansion of the railway system and its added traffic threw more work into them. There is no organic unity about the planning of the shops, and there is much unnecessary handling of materials. In the erecting shop the overhead traveller is not capable of lifting the largest locomotive engines employed on the line; but this is to be remedied as soon as a 40-ton traveller can be obtained from home. The foundry is a very large shop, but its roof is much too low, and it is, in consequence, ill-ventilated and hot. Although there is a good deal of repetition work, no modern moulding machinery is employed, and the organisation of the labour in the foundry is on extremely primitive lines. The machine shop is overcrowded with what may be described as antiquated plant which is, presumably, still retained because it is good enough for the class of work which finds place in a locomotive, and because it is well suited to the capacity of the men who are employed. Better tools, capable of a much larger outturn, would require a higher type of machinist than has so far been trained. The power house is of recent construction, and is a very fine piece of work, quite up-to-date. It contains 2 sets of Belliss & Morecombe engines, each driving alternators of about 1,000 k.w., capacity, and there are also 2 steam turbines and alternators of smaller size. The steam is supplied by a battery of Babcock & Wilcox boilers, and the arrangements for handling the fuel and ashes are of modern design. Chain-grate stokers are employed, and the fuel used is inferior slack which, judging from the very faint smoke emitted from the chimneys, is burnt with very great success.

One of the special features of Jamalpur is the steel plant. Two open-hearth basic furnaces have been installed, but unfortunately these were not at work, owing to the supplies of pig iron from Kulti having been stopped. The rolling mills are comparatively small, and are not capable of rolling large sections. At Sakchi the rolls are made of cast iron, but here it is thought necessary to employ steel, and they are made from steel ingots cast locally. Besides rolling sections, large quantities of steel castings are turned out, including steel wheels complete, with the exception of the tyres.

There was evidence of a considerable amount of ingenuity in meeting difficulties brought about by the shortage of materials, and some very interesting experiments were witnessed with an electric welding plant, which has recently been constructed. In one instance, two lengths of steel boiler tubes were welded together, and, in the other, a core of high-speed tool steel was welded into a tool holder. Jamalpur claims to have been the first locomotive

workshop to have utilised old tyres in the manufacture of steel-spring plates. The electrical repair shops are unusually complete. Here, samples of locally made micanite were shown to us, and the shortage of wire is to be met by the installation of a wire-drawing plant. In the shops themselves a number of machine tools, which could not be got out from home, were under construction, and a considerable amount of work was in hand for the Expeditionary Force in Mesopotamia. There is a very complete plant for making bolts and nuts and dog spikes, but as the output is not sufficient to meet the present demands, new machines are being made to increase it.

In common with all Indian Railways, it has always been deemed necessary to employ a large staff of European foremen and chargemen; but of late the view has been gaining ground among the railway officers that some of these men might be replaced by Europeans or Anglo-Indians trained in the country, provided they could afterwards get employment for a year or two in British locomotive shops. Accordingly, the East Indian and several other Indian railways have made special provision for the training of European and Anglo-Indian apprentices. At Jamalpur these arrangements are probably of a more advanced character than elsewhere. At the time of our visit, there were 92 apprentices living in the hostel. These boys are taken on as apprentices for 5 years, and are paid wages on an incremental scale. The hostel accommodation provided for them is excellent, and they all share a common mess room. Each apprentice is expected to attend class instruction for 3 hours a week, of a character very similar to that we inspected at the Calcutta Evening Technical School. At Jamalpur we saw the boys at work in the classes in the early morning, and though there were a fair number of exceptions, the majority of them appeared to take very little interest in their work. This was confirmed by the instructors, who are members of the permanent staff of the workshops. They say that the greatest difficulty in dealing with Anglo-Indian boys is their lack of ambition. No provision is made for the technical instruction of, or for housing, Indian apprentices, the majority of whom are the sons of men employed in the railway. There is a small number of Indian apprentices belonging to the educated classes, but they are left to shift for themselves. Few of them are reported to do well, and this seems hardly surprising, considering how little interest is taken in their welfare.

The senior officers of the company recognise this, and are extremely anxious to co-operate in any well-devised scheme to provide more intelligent workmen than they are now able to obtain, and to create a class of men who will ultimately be fit to be entrusted with supervisory work. There was general agreement between the European officers at Jamalpur that the outturn of work per man was not more than one-third that of corresponding workmen in British shops. The very much lower rates of wages prevalent in Indian workshops counterbalance this, except where machinery is largely employed. The cost of doing work by machinery is made up, not only of the general charges and of the cost of raw materials, and of the labour employed upon it, but to these items must also be added the charges on account of interest on the capital locked up in the machines, and the amount which it is annually necessary to set aside for depreciation and repairs. The Indian workman is apparently only capable of getting about one-third of the proper outturn from a machine, with the result that much work is still done by hand, which, with better workmen, might well be done by machinery. This, we think, is largely due to the very inadequate arrangements made to train machinists, and it appears to us, to be beyond doubt that a great improvement could be effected among these workmen by giving them some technical training. Obviously this cannot be done in the shops themselves, and class instruction should be provided for them in a technical school alongside. There will be difficulty in getting suitable instructors, as the classes will have to be held in the vernacular, and a man possessed of the necessary knowledge and experience, and capable of imparting it to others, not in his own language but in Hindustani, will undoubtedly be hard to find. It will, however, pay well to offer special inducements to get men to qualify for such work, as the inefficient use of machinery in Indian workshops represents an enormous loss to the country. Assuming, in Jamalpur alone, that the

output from 30 lakhs of rupees worth of machinery could be doubled, it would represent an annual saving in running costs of several lakhs of rupees.

The potentialities of Jamalpur for training all classes of men employed in mechanical engineering appear to us to be excellent; but so far very little use has been made of them. Even the Anglo-Indian apprentices are turned into the shops and left very much to themselves. What appears to be necessary is that there should be special officers attached to the workshops, whose duty would be to see that the apprentices were properly instructed and were given a sufficient variety of experience. It must be recognised that this can only be done to a limited extent in the workshops and that it is futile to leave it to be done by the men. The apprentices should be assembled in small classes, at least once a week, for the special purpose of receiving instruction regarding the work they are engaged on in the shops. For instance, the boys working lathes should have explained to them the construction of a lathe, the special features of its design, the means adopted to obviate wear and tear, the methods of holding work, the use of jigs, and the principles underlying the action of the cutting tools. Such instruction can only be given in a classroom provided with a lathe suitable for demonstration purposes; and with a capable instructor the apprentices will learn as much about lathe work in a few hours as they would probably pick up in the shops in the course of a year. What applies to the training of workmen, who, from the beginning, specialise, applies with much greater force to apprentices whose training covers a much wider field; and, of course, most of all, to the comparatively small number of more intelligent and better educated youths who come into the shops with a view to becoming mechanical engineers. Hitherto, this workshop training has been of the most haphazard kind, and, without doubt, many a youth has been disgusted with it, through inability to overcome the initial difficulties. We recognise now that this state of things must be put an end to, and that in future the methods of training apprentices must be as scientific and precise as those for handling and manipulating the raw materials in course of manufacture. At Jamalpur we had the advantage of discussing these matters with Sir Robert Highet, the Agent of the Railway, with Mr. Wedderburn, the Locomotive Superintendent, and with his chief assistants, and would record, with satisfaction, the singular unanimity with which our proposals were received, not because they were in any way novel, but because, when developed, they coincided completely with the ideas which have been floating in the minds of these officers as the result of practical experience.

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